AC A446(2) C.I. MANCHESTER

BUREAU OF HYGIENE & TROPICAL DISEASES
LIBRARY
21 NOV 1927

CITY OF MANCHESTER.

Rivers Department.

ANNUAL REPORT

FOR THE

Year ending March 30th, 1927.

Price: Three Shillings and Sixpence.

Printed for the Manchester Corporation by
HENRY BLACKLOCK & CO. LIMITED, MANCHESTER,
and may be purchased either directly or through any Bookseller from
P. S. KING & SON, LIMITED,
Orchard House, Victoria Street, Westminster, London, S.W.

67157

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE
LIBRARY
-4 MAR 1968

BUREAU OF
21 NOV 1927

City of Manchester.

RIVERS DEPARTMENT.

Annual Report

FOR THE

YEAR ENDING MARCH 30th, 1927.

Rivers Department,
Town Hall,
Manchester.

MEMBERS OF THE RIVERS COMMITTEE,

1926-1927.

CHAIRMAN—Alderman Fred J. West, C.B.E., J.P.

DEPUTY-CHAIRMAN—Councillor Thomas R. Hewlett, J.P.
THE LORD MAYOR.

Councillor Thos. Dunham, J.P.
,, John Elliott
,, Isaac Floyd
,, David Gouldman
,, Thomas Harrison
,, John E. Hutchinson
,, William Johnston
,, James C. Kidd
,, Herbert Levinstein

Councillor Henry F. Robinson
,, John Sever
,, Robert W. Shepherd
,, John W. Sutton, J.P.
,, George G. Wellings
,, John M. Wharton
,, G. Harold White, J.P.
,, John Williams, J.P.

CONSULTING CHEMIST—Edward Ardern, D.Sc., F.I.C.

SECRETARY—George F. Walter, F.C.I.S.

(2992)

CITY OF MANCHESTER

Rivers Department.

Annual Report for the Year ending March 30th, 1927.

The Rivers Committee submit to the Council the following report on the work of the Rivers Department :—

Introductory.

The duties of the Rivers Committee are defined in the Council's Instructions to Committees, as follows :—

> " To enforce and carry out the provisions of any public or local Act, or any legal remedy with respect to the rivers, brooks, or streams, wholly or partially within the City, and with respect to all other matters connected therewith ;
>
> " That the said Committee be authorised and instructed to carry out and complete the Manchester Main Drainage Scheme, including all works in relation thereto, and for those purposes to exercise the powers of the Corporation under the Public Health Acts ;
>
> " Also to execute the powers and duties of the Council with respect to the Sewage Outfall Works of the Corporation under paragraph 2 (2) of the Fifth Schedule of the Manchester Corporation (General Powers) Act, 1904 (Chorlton-cum-Hardy Sewage Works to be used only for 3 Withington and 2 Levenshulme Wards) ; Part IV. (Sewerage) of the Manchester Corporation Act, 1908 ; Part V. (Sewerage) of the Manchester Corporation Act, 1909 ; Part IV. (Main Drainage Works) (except section 50) of the Manchester Corporation Act, 1911, and under any other local enactment ; also the provisions as to the discharge of certain matters into sewers, contained in section 21 of the Manchester Corporation (General Powers) Act, 1902, and the orders thereunder ; also to carry out and enforce the provision enabling the Corporation to define the boundaries of rivers, brooks, and watercourses contained in section 55 of the Manchester Corporation Act, 1911 ;
>
> " Also to direct and manage the powers, authorities, and duties of the Council under the Rivers Pollution Prevention Acts, 1876 and 1893 ; section 14 of the Local Government Act, 1888 ; and sections 16, 17, and 47 of the Public Health Acts Amendment Act, 1890."

The total length of sewers constructed under the Manchester Corporation Acts, 1908 and 1911, and completed to date, is 28·25 miles, of which 4·5 miles were executed by the Committee's staff without the intervention of a contractor.

The sewers vary in size from 2·25 ft. to 15·25 ft. in diameter. They are constructed with red engineering bricks and shale bricks set in cement mortar. No surface clay bricks have been used.

Owing to the presence of water in the subsoil, considerable lengths of sewer have had to be executed under air pressure. The completed sewers pass beneath the London, Midland, and Scottish, the London and North Eastern, the Manchester, South Junction, and Altrincham, and the Cheshire Lines Committee Railways in seventeen places, and cross the Bridgewater Canal in seven places.

The Rivers Committee control the admission of all trade effluents into the sewers, according to the provisions of the before-mentioned Acts, and a special Inspector has charge of this work.

The main activity of the Committee is, however, connected with the disposal of the City sewage.

With the exception of the sewage from the Withington district, which receives treatment at the Withington Works, Chorlton-cum-Hardy, the whole of the dry-weather flow of the City sewage has been dealt with during the year at the main outfall works at Davyhulme. Only such portions of the Moss Side Works at Urmston and the Gorton Works at Gorton have been retained as are required for the treatment of exceptional flows of storm water.

In addition to the sewage from within the City area, since October 1st, 1915, the sewage from the Borough of Middleton has also been dealt with at Davyhulme.

The following statements show in summarised form the details of the Committee's expenditure for the year under review :—

The total charge on the rates in respect of the work of the Committee was £224,539 2s. 3d.

Of this amount, a sum of £59,283 9s. 11d. was required for the upkeep of the Davyhulme, Withington, Moss Side, and Gorton Sewage Works, and for general rivers work, comprising the administration at the Town Hall, the cost of labour and various rivers improvements, contribution to the Mersey and Irwell Joint Committee, etc.

The remainder, amounting to £165,255 12s. 4d., was applied in the payment of interest on loans and repayment of debt on the capital outlay on intercepting sewers throughout the whole of the City, and the purification plant at the various sewage works.

The details are as follow :—

	£	s.	d.	£	s.	d.
Administration and Upkeep.						
Davyhulme Sewage Works.. ..	*46,556	16	10			
Withington	6,647	3	4			
Moss Side	155	18	8			
Gorton	315	0	9			
Rivers Account	5,100	15	8			
Main Drainage Scheme (1911) ..	507	14	8			
				59,283	9	11
Interest on Loans and Repayment of Debt.						
Manchester	†67,555	17	5			
Withington	7,405	5	10			
Moss Side	51	17	11			
Gorton	1,763	3	8			
Rivers Account	521	4	6			
Main Drainage Scheme (1911) ..	87,958	3	0			
				165,255	12	4
Total				£224,539	2	3

The Report is in two parts :—

Part I. deals with the work in connection with the Maintenance of Rivers and Streams and the Inspection and Control of the Manufacturers' Trade Refuse discharged into the City Sewers.

Part II. deals with the Administration of the Withington, Moss Side, Gorton, and Davyhulme Sewage Works.

---

* This amount represents the net cost to Manchester after deducting contributions from Audenshaw, Stretford, Barton, and Middleton Authorities (see Table II. footnote).

† Included in this figure is a sum of £31,000 (approximately), the annual charge on the capital outlay on the Manchester Sewers (apart from the Main Drainage Scheme, 1911), amounting to £627,091.

PART I.

MAINTENANCE OF RIVERS AND STREAMS.

The work of the river men has been distributed as follows :—

	Days
River Medlock.	
Between Pin Mill Basin and Fairfield Street...	46
,, Fairfield Street and Temperance Street	18
,, Hoyle Street and Mayfield	70
,, Mayfield and Westhead's Weir	22
,, Green Lane Yard and Charles Street	39
,, Charles Street and Oxford Road	22
River Irk.	
Removing shoals at Collyhurst Road	24
Cornbrook.	
Removing debris, etc., Bennett Street, etc.	10
Westhead's Weir.	
Drawing weir and impounding water at week-ends, attending sluices during floods and repairs	89
Green Lane Depot.	
Repairing tackle and waders, limewashing, etc.	49
Miscellaneous	6
Assisting Rivers Inspector in examinations of trade effluent entering sewers, etc.	209

INFRINGEMENTS OF MANCHESTER CORPORATION ACTS, 1869, 1871, 1884, ETC.

Twenty-six cases of infringement of the above Acts have been dealt with.

Tipping on river banks within reach of floods, obstructions of waterways, and the casting of refuse into streams were the offences usually complained of.

Resort to legal notice was necessary only on rare occasions, as compliance with the requirements of the Corporation was usually obtained without difficulty.

In several instances the work required was done by the Corporation at the cost of the offenders.

TRADES REFUSE IN SEWERS.

A large number of samples from sewers and works liable to discharge effluents of an objectionable character have been examined, and the proprietors of certain works have been called upon to exclude improper discharges. The offending matters complained of are generally acid discharges, excessive quantities of solid matter in suspension, and effluents containing sulphides.

PETROL IN SEWERS.

Section 41 of the Public Health Act, 1925, which prescribes heavy penalties for the "wilful or negligent" discharge of petrol into sewers, has been delegated to the Paving, Public Health, and Rivers Committees for administration.

An arrangement has been made with the Petroleum Officer for the incorporation in a notice as to naked lights—the exhibition of which notice is compulsory on licensees—of a clause relating to petrol discharges into drains and setting forth the penalties for infringement.

It is to be noted as a matter of interest that the Petroleum Officer is empowered to require the provision by petrol licensees, at drain inlets in the proximity of their stores, of an efficient intercepting chamber for the prevention of accidental discharges of petrol into sewers.

WESTHEAD'S WEIR.

At this weir there are three tilting flood gates, and damage to the left gate by floods, together with certain renewals, have required repairs costing £104.

FLOODS.

On October 14th, 1926, a considerable flood occurred in the River Medlock, when the water rose to the heights recorded below :—

	ft.	in.
Pin Mill Bridge	8	5
Helmet Street Tunnel	8	8
Fairfield Street Bridge	8	11
Hoyle Street Bridge...	8	10
Mayfield Tunnel	8	6
Downing Street Bridge	8	8
Jackson Street Bridge	8	5
Green Lane Yard	9	9
Brook Street Bridge	9	3
Oxford Road Bridge	7	6
Birley's Tunnel...	6	6
Birley's Weir (on sill)	5	0
City Road Bridge	6	9
Knott Mill Swallow (on sill)... ...	5	11

During the year plans have been submitted to the Committee for the following :—

Gorton Brook ...	... Proposed building on bank at Gorton.
Shaw Brook ...	... Diversion and culverting at Withington. Culverting at Burnage.
Nico Ditch ...	... Covering at Old Hall Lane, Rusholme.
Chorlton Brook	... Culverting at the new park, Chorlton-cum-Hardy.
High Lane Brook	... Culverting at Burnage.
River Medlock ...	... Widening of Oxford Road Bridge. Projections over the river at Chorlton-upon-Medlock.

Considerable repairs to the invert of the River Medlock have been effected at Clayton Vale under a special estimate approved by the Council. Following an inspection of a Special Sub-Committee, a short length of the River Irk at Collyhurst was cleared out at the cost of the ratepayers.

PART II.

THE TREATMENT OF SEWAGE AT THE WITHINGTON WORKS.

Description of Works.

These works came under the control of the Rivers Committee upon the inclusion of the Withington Urban District Council District within the City on November 9th, 1904. They are situate at Chorlton-cum-Hardy, at the extreme western corner of the district, and are bounded by the River Mersey on two sides—south and west—the Chorlton Brook on the north, and an embankment on the east.

These works were originally designed to purify the sewage by treatment on the land. Subsequently a sedimentation tank and double-contact filter plant was installed as follows:—Two detritus tanks (capacity 83,400 gallons), two sedimentation tanks (capacity 781,000 gallons), ten first contact beds (2,900 superficial yards each), ten second contact beds (2,900 superficial yards each), and an area of storm beds of 12,452 superficial yards divided into four plots measuring respectively 2,882, 3,533, 3,751, and 2,286 superficial yards. A conical catch-pit in connection with the high-level sewer was constructed later (*see* report for the year ending March, 1911). In 1914 two Emscher (double-decked) tanks were constructed of sufficient capacity to deal with from 600,000 to 700,000 gallons per day, a general description of which appeared in the report for the year ending March, 1915.

A continuous-flow unit for the treatment of the sewage by the activated-sludge process was brought into operation in October, 1917, and occupies one-third of one of the above-mentioned sedimentation tanks. A complete account of this plant, together with plan, was given in the Annual Report for the year ending March, 1918.

An additional larger Activated Sludge Unit was brought into commission in August, 1923, and occupies one-third of one of the original second contact beds. A complete description of this installation was given in Appendix I. to the report for the year ending March, 1924; a plan of the same appeared in the annual report for the year ending March, 1923.

A general plan showing the arrangement of the present works appeared in the annual report for the year ending March, 1923.

The land is practically level throughout; consequently it was found necessary, in order to carry out the scheme of double-contact beds, to raise the sewage at the outfall works, and, in order to avoid pumping the whole, to arrange the new outfall main sewers to gravitate the sewage of the upper zone of the district and the whole of the Levenshulme sewage, leaving only that from Didsbury and Chorlton-cum-Hardy to be pumped.

With the River Mersey and Chorlton Brook at ordinary level, the effluent is passed into the latter at a point some 300 yards above its junction with the Mersey; but when the river and brook are in flood it is passed by a syphon under the Chorlton Brook into the Ousel Brook at a point near the Stretford Cemetery, and about half a mile below the Sewage Works. In addition to this, there is a storm-water reservoir nine acres in area for impounding storm water from the Chorlton-cum-Hardy district, as well as a portion of the effluent from the works. When the River Mersey is about its normal level this storm-water reservoir is discharged by gravitation into the river; but should the river be in flood, it is then pumped by means of a suction-gas pumping installation.

In connection with the present main drainage scheme, arrangements have been made whereby the sewage from Levenshulme and Mauldeth Road can be diverted either to the Withington Works or into the main City outfall. No diversion of this sewage to the Davyhulme Works was necessary during the year reported upon.

The total population at present connected with the works is 72,600, viz., Withington 48,900 and Levenshulme 23,700.

The average daily flow of sewage (including storm water) for the year under observation amounted to 4,018,000 gallons, or 55 gallons per head of population per day.

With the exception of the suction gas plant referred to above, the whole of the power used on the works is now derived from the Corporation Electrical Supply.

The plant in the engine room comprises four centrifugal pumps for lifting the low-level sewage, air compressor for delivering the sludge through mains on to the land, and air compressors for the operation of the activated sludge installations, all driven from electric motors of from 15 to 60 H.P.

In addition, there are small motors attached to screens placed on high and low level sewers, and for driving chopping machine.

AREA OF LAND.

The total area of land comprising the Withington Sewage Works amounts to 92·5 acres, and is divided up as follows :—

	Acres.
Land occupied by detritus, sedimentation, and activated sludge tanks	2·25
Land occupied by buildings and sludge tank	
Land occupied by lay-byes and storage	
Land occupied by storm-water reservoir	9
Land occupied by bacteria beds	11·75
Land occupied by storm-water filters	2·5
Total area of land occupied	25·5
The area of land not occupied by bacteria beds, storm-water filters, buildings, tanks, etc., but under cultivation	67·0
Grand total	92·5

Of the land not utilised for sewage treatment, an area of 21½ acres has again been let for a portion of the year as grazing land. Each year there is keen competition for this land, as, owing to the numerous housing schemes, local farmers are being dispossessed of their grazing facilities. During the year this land has brought in a revenue of £85 5s., although only let for seven months.

RIVER MERSEY BANKS.

There have been no serious disturbances during the year of the River Mersey banks bounding these works, and the amount expended on their maintenance and repair is therefore negligible.

Owing to the rapid rise and fall of the River Mersey the department is always menaced by the possibility of a serious break in the banks, and every opportunity is taken to acquire brushwood and other material suitable for repair work.

At the date of this report the large break in the bank on the Cheshire side of the river has been repaired, and a source of considerable danger to the stability of the bank on the Committee's land has thus been removed.

VOLUME OF SEWAGE TREATED.

The volume of sewage actually delivered at these works is estimated at 1,462,489,000 gallons, an average of 4,018,000 gallons per day. The details of the flow, together with the volume in terms of per head of population and rainfall records, are given in the following table :—

Sewage Flows.

Period of 4 weeks ending	Total Flow.	Average Daily Flow.	Average Daily Flow.	Rainfall.
	Gallons.	Gallons.	Gallons per head.	Inches.
1926				
April 28th	78,150,000	2,791,000		1·17
May 26th	91,998,000	3,286,000		2·38
June 23rd	101,159,000	3,613,000		2·84
July 21st	89,486,000	3,196,000		2·02
August 18th	110,243,000	3,937,000		3·98
September 15th......	98,669,000	3,524,000		2·85
October 13th	113,829,000	4,065,000		4·86
November 10th......	129,400,000	4,621,000		3·00
December 8th	142,459,000	5,088,000		3·11
1927				
January 5th	105,352,000	3,762,000		1·28
February 2nd	142,433,000	5,087,000		2·80
March 2nd............	125,065,000	4,467,000		2·01
March 30th	134,246,000	4,794,000		2·30
Total for 52 weeks...	1,462,489,000	4,018,000	55	34·60
Total for 53 weeks ending Mar. 31st, 1926	1,524,954,000	4,110,000	58	33·43

A measurable rainfall occurred on 213 days, as compared with 208 days during the previous year.

SLUDGE DISPOSAL.

In the following table is given the amount of sludge removed during the year from the various tanks :—

	Tons.
Screening, etc.	400
Conical Tank	600
Detritus Tanks, Sedimentation Tanks, and Activated-sludge Tanks	19,250
Emscher Tanks	1,010
Total	21,260

The total amount of sludge produced, viz., 21,260 tons, is equal to 14·5 tons per million gallons.

The sludge from the detritus, sedimentation, and activated-sludge tanks has been trenched into the land as usual.

EMSCHER TANKS.

A general description, together with plan, of these tanks was given in the Report for the year ending March, 1915.

The tanks have been in continuous operation throughout the year, and have dealt with 254,242,000 gallons of sewage, an average of 698,000 gallons per day, as compared with a daily flow of 642,000 gallons during the preceding year.

A total of 810 tons of sludge were discharged from the tanks on to the drainage beds provided, and approximately 200 tons of "scum," containing about 80 per cent. of water, have been removed from the vent chambers. The air-dried sludge has been used on the land under cultivation.

FILTRATION OF EFFLUENT FROM SEDIMENTATION AND EMSCHER TANKS.

Of the total flow of 1,462,489,000 gallons of sewage received at the works, 368,780,000 gallons were treated by the activated-sludge process, and the remainder, viz., 1,093,709,000 gallons, were dealt with on the filtration areas.

The storm beds dealt with a total volume of 167,092,000 gallons, which is equal to 184,000 gallons per acre per day. The primary and secondary beds dealt with a total volume of 926,617,000 gallons, which means that on the average (including all periods of rest), tank effluent was applied to the primary beds at the rate of 424,000 gallons per acre per day.

The work on the surface of the filter beds in connection with the removal of accumulated sludge and of heavy growths of weeds, etc., has proceeded as usual, the cost of which for the various filtration areas is given in Table I.

TREATMENT OF SEWAGE BY THE ACTIVATED-SLUDGE PROCESS.

Purification plant in operation for the treatment of sewage by the activated-sludge process—diffused aeration system—consists of (i.) a small continuous-flow unit installed in 1917, and described with plan in the Annual Report for the year ending March, 1918, and (ii.) a large-scale continuous-flow unit installed in 1923,* and described with plan in the Annual Report for that year.

The air-compressing plant comprises two reciprocating compressors, driven by 30 H.P. electric motors, each capable of compressing approximately 700 cubic feet of free air per minute, and a modern type compressor (installed in 1924), driven by a 25 H.P. electric motor, capable of compressing 400 cubic feet of free air per minute. One of the larger compressors is used as a stand-by.

The normal working pressure is 4lbs. per square inch.

Each purification unit is provided with meters, etc., for recording the volume of sewage treated and the volume of air used. A meter is also provided for the measurement of the electrical units consumed.

Prior to passing to the aeration tanks the sewage is screened and freed from the coarser suspended solids by passage through detritus tanks having a capacity equivalent to 40 mins. D.W.F.

During the past year a total volume of 368,780,000 gallons of screened and detritus-free sewage has been treated by the two units, which represents approximately 25 per cent. of the total volume of sewage received at the works.

---

* For experimental purposes this plant has been modified to some extent during the past year, as described on page 16.

SMALL-SCALE UNIT (RIDGE AND FURROW TYPE).

This unit has been in continuous operation throughout the year. The average analytical returns, etc., are tabulated below :—

SMALL UNIT.

Results in Grains per Gallon.

	Screened and detritus-free Sewage	Effluent
Four hours oxygen absorption	2·77	·48
Three minutes oxygen absorption :—		
Before incubation	1·02	·19
After incubation	—	·17
Putrescibility	—	10½/246
Free and saline ammonia	2·16	2·08
Albuminoid ammonia	·61	·135
Nitrite (in terms of NH_3)	—	trace
Nitrate (in terms of NH_3)	—	·12
Biochemical oxygen demand (†Royal Commission Test)	—	·86
Suspended solids	9·6	·46

Total volume of sewage treated	130,875,000 gallons
Volume of sewage treated per day (average)	360,000 ,,
Air consumption :—Free air per gallon of sewage treated	1·13 cubic feet
Average detention period :—	
Aeration tank (capacity, 60,000 gallons)	4·0 hours
Settlement tank (capacity, 27,000 gallons)	1·8 ,,

---

† Standard recommended not more than 1·40.

It may be of interest to mention that this unit has been in continuous operation since November, 1921, except for a period of five days, when the flow of sewage to the plant was stopped to permit of the construction of new sewage carrier, and that, throughout this period, no difficulty has arisen with regard to sludge control.

The performance of the unit during the last six years is outlined in the following table :—

WITHINGTON SMALL-SCALE ACTIVATED-SLUDGE UNIT.

(Type : Ridge and Furrow. Capacity of aeration tank, 60,000 gallons.)

Summary of Results of Operation, 1922-27.

Year ending March ...	*1922*	*1923*	*1924*	*1925*	*1926*	*1927*
Average volume of sewage treated per day (gallons)	263,000	320,000	357,000	366,000	365,000	360,000
Air consumption (cubic foot free air per gallon of sewage treated)	1·35	1·26	1·08	1·08	1·11	1·13

From the above results it will be seen that the high standard of efficiency reached during the year ending March, 1924, has been well maintained during the past year.

(*b*) LARGE-SCALE UNIT.

Since the last report the construction of this unit has been modified to some extent in order to provide conditions suitable for experiments with respect to the "relative efficiencies of aeration chambers of different design."

The modification comprised (1) provision of means to convey activated-sludge direct from the settlement tank to the inlets of the aeration chambers, *i.e.*, without re-aeration ; and (2) remodelling of one of the aeration chambers so as to furnish the aeration channel thereof with a trough-shaped bottom (longitudinal furrow) having diffusers arranged end to end along the middle of the said channel and at the base of the trough.

In consequence of these alterations and to allow for the required experiments to be made, the plant, throughout the greater portion of the year, has not been worked to its full capacity.

Actually, the plant was out of commission for 39 days, and on 254 days one only of the two aeration chambers available for sewage purification has been in use.

VOLUME OF SEWAGE TREATED DURING THE YEAR.

Despite the restrictions imposed, during the whole period of operation (325 days), a total volume of 237,905,000 gallons of screened and detritus-free sewage, equivalent to an average daily volume of 732,000 gallons, were treated in this unit, with an average air consumption of 1·30 cubic feet (free air) per gallon of sewage dealt with.

Analytical data with respect to the average composition of the sewage treated during the year and the effluents obtained are given below :—

LARGE-SCALE UNIT.

Results in Grains per Gallon.

	Screened and detritus-free Sewage	Effluent
Four hours oxygen absorption	2·77	·50
Three minutes oxygen absorption :—		
Before incubation	1·00	·20
After incubation	—	·19
Putrescibility	—	25/221
Free and saline ammonia	2·12	2·10
Albuminoid ammonia	·61	·145
Nitrite (in terms of NH_3)	—	trace
Nitrate (in terms of NH_3)	—	·12
Biochemical oxygen demand (†Royal Commission Test)	—	·84
Suspended solids	9·6	·48

† Standard recommended for effluents = not more than 1·40 grains per gallon.

A detailed account of the operation and performance of this plant is given in Appendix I. to this report.

MOSS SIDE SEWAGE WORKS.

The storm-water overflow at these works came into operation on 72 occasions during the year ; the average depth measured over a 6ft. sill was 8½ inches.

The total amount of semi-dried sludge removed from the storm-water lagoons was 107 cubic yards.

The River Mersey overflow channel did not come into operation during the year, presumably on account of the relief afforded by the break on the Cheshire side of the river in the Sale district, the complete repair of which was not effected until May, 1927.

GORTON SEWAGE WORKS.

These works are now completely out of commission inasmuch as the storm-water, which was formerly dealt with on a filter on the south side of the works, was finally diverted in April, 1926.

Permission was given during the year to the Electricity Department to instal an electric main inside the works in anticipation of the setting back of the works boundary wall consequent on the widening and improvement of Mount Road.

A large area of land at East Road, Gorton, which has for many years past been in the tenancy of the Agricultural Committee for use as allotment gardens, has, with the consent of the Ministry of Health, been transferred during the year to the Housing Committee, the necessary financial adjustmsnts having been made.

THE TREATMENT OF SEWAGE AT DAVYHULME.

Description of Works.

The original works, which came into operation early in 1894, were designed for the treatment of the sewage by chemical precipitation.

The new works for bacterial treatment of the sewage were completed in 1904 so far as to permit at that date of the whole of the dry-weather flow being dealt with in tanks and primary contact beds.

A general plan showing the arrangement of the existing works appeared in the Annual Report for the year ending March, 1923.

The sewage as it reaches the works passes through a system of screens and catch-pits, designed to intercept coarser floating matter and heavy detritus. The flow is either passed through open septic tanks on to primary bacteria beds, or, after simple sedimentation, on to the storm beds.

The sludge which settles or accumulates in the course of time in the septic tanks flows by gravity, or is pushed by manual labour, into the channels leading to two ejectors, from which the majority of the sludge is forced under air pressure into three storage tanks near the banks of the Ship Canal below Barton Locks. From these tanks it flows by gravity into the sludge steamer, and is deposited at sea beyond the Mersey Bar. A small proportion of the sludge is dealt with in presses, and the resultant pressed cake either before or after drying is disposed of as a fertiliser.

A complete description of the scheme originally sanctioned by the Local Government Board is given in the report, entitled "Treatment of Manchester Sewage," issued in July, 1902, where the details of construction of the primary contact beds and storm-water beds may be found.

Subsequently permission was granted by the Board to construct the secondary beds at Bent Lanes, adjacent to the original works, instead of at Carrington and Flixton.

A general description of the construction of the secondary beds is given in the Annual Report for the year ending March, 1909.

Power Supply.

The steam plant was displaced in September, 1923, and since February 2nd, 1924, the works have been supplied with current by the Corporation Electricity Department by direct cable from the Barton Power Station, at a pressure of 6,600 volts to two 250 K.V.A. transformers, where it is stepped down to 440 volts for power and 220 volts for lighting purposes.

Panel switch-boards, complete with main cut-outs and meters, are provided for both high and low tension current.

The motors throughout the works are designed for 3-phase, 50 cycle, A.C. current, and have a total working output of 466 B.H.P.

There are two 60 B.H.P. motors for driving Alley-McLellan air compressors (high pressure) for operating sludge ejectors and sludge presses ; two 47 B.H.P. motors driving two 10in. Gwynne " Invincible " pumps, each capable of delivering 2,500 gallons per minute against a 40 foot head, employed for pumping off top water from sedimentation and septic tanks prior to removal of sludge ; three 30 B.H.P. motors for driving three Reavell air compressors (low pressure) employed in connection with the Activated Sludge plant ; one 30 B.H.P. motor driving a Ruggles-Coles dryer, and one 24 B.H.P. motor also used in connection with sludge drying ; one 20 B.H.P. motor used for driving purposes in the fitting shop ; two 20 B.H.P. motors for operating sewage screens and elevators ; two 10 B.H.P. motors for operating the two clinker washing plants ; and four small motors from 1·5 to 8 B.H.P. used for sundry other purposes.

DRAINAGE OF THE PARISH OF DAVYHULME.

Some time ago an agreement was entered into with the Barton Rural District Council to treat the sewage from the Davyhulme Parish at the Davyhulme Works.

The sewage contributed by the population in Crofts Bank Road, Barton Road (part of), Davyhulme Road, and Bent Lanes is discharged at two points—*i.e.*, Point " C " and Point " E." That discharged at Point " C " passes over shallow filter beds, and then into the feed channel to the secondary beds.

The sewage delivered at Point " E " is conveyed by means of a 2ft. diameter brick sewer, on which a storm-water overflow is fixed at the Bent Lanes Brook, and which is intended to limit the volume of sewage passed on the estate of the Corporation. The sewage is delivered into a manhole referred to in the Agreement as Point " E." and from which it gravitates through three 6in. diameter cast-iron pipes to a " recorder chamber," where the flow is measured by means of a " V " notch of the type designed by Messrs. Lea, of Manchester, and has a maximum recording capacity of 10,000 gallons per hour. After passing over the notch the sewage flows on to pneumatic ejectors of 200 gallons capacity, in duplicate, each fixed in cast-iron tubbing.

These ejectors raise the sewage by means of compressed air, supplied from the main engine house at the works, into the feed channel supplying the existing septic tanks.

Area of Land.

The total area of land comprising the Davyhulme Works amounts to 238·5 acres, and is divided up as follows :—

	Acres
Land occupied by storm water, detritus, open septic tanks, and activated-sludge plant	10·1
Land occupied by buildings, sludge tanks, etc., and land occupied in connection therewith..	15·0
Land occupied as wharves, lay-byes, and storage	5·0
Land occupied by first contact bacteria beds..	46·0
Land occupied by second contact bacteria beds	39·0
Land occupied by storm-water filters	26·8
The area of land not occupied by bacteria beds, buildings, tanks, etc., but includes existing roads, railway and embankments, and disused river bed..	96·6
Grand total	238·5

Tenancies, etc., of Lands.

During the year covered by this report the Committee's lands at Carrington and Flixton have been supervised from the Town Hall as heretofore, and periodical inspections of crops have been made by the official of the Agricultural Committee of the Corporation. Certain drainage work has been carried out on the Carrington land.

A permanent water supply has been laid on to the land in the Flixton meadows. The laying of the sludge main, referred to in the last report, is now well advanced (September, 1927), and it is expected that this land will be used for sludge disposal in the course of a few months. The Gas Department's high-pressure main from the new Partington Gas Works was also being laid through the Carrington and Flixton lands, and the Rivers Committee have agreed to contribute towards the cost of the bridge across the River Mersey in order to obtain accommodation for the sludge main against the time trenching on the Carrington side of the river is undertaken.

One or two minor alterations of tenancy have been necessary as a result of the laying of the sludge main from Davyhulme to Flixton, and several claims for compensation in respect of disturbance and surface damage and loss of crops have been met.

The proposal to redeem certain tithes payable out of lands comprising the Flixton Estate, referred to in the last report, has been carried into effect.

The whole of the Flixton lands in the River Mersey meadows continue to be cropped by the department. The total area of land let to farmers, etc., at the date of this report is approximately as follows :—

	Area			Annual Rental		
	a.	r.	p.	£	s.	d.
Townships of Stretford and Davyhulme	12	3	9	21	9	5
Township of Carrington ..	89	3	10½	94	6	2
Township of Flixton	56	0	20	126	0	6
Totals	158	2	39½	£241	16	1

River Mersey Banks.

The Committee's lands in the Flixton meadows have a frontage of approximately 3,500 yards to the River Mersey, and the banks are subject to considerable erosion in times of flood. With the continuous presence of Davyhulme workmen engaged in land cultivation operations, a thorough watch has been kept on the banks during the year, with the result that slips of the banks have been noted early and the necessary repairs effected before extensive damage has developed.

Volume of Sewage Treated.

The volume of sewage delivered at the works from April 1st, 1926, to March 30th, 1927 (inclusive), including 20,452,000 gallons from the Parish of Davyhulme, was 17,512,465,000 gallons.

The average daily flow of sewage was 48,111,000 gallons, showing a decrease on the previous year of 871,000 gallons, or 1·7 per cent.

The average daily flow of sewage per head of population has ranged from a minimum of 55 gallons for the four weeks ending July 21st, 1926, to a maximum of 76 gallons for the four weeks ending February 2nd, 1927.

Monthly Recorded Sewage Flow and Rainfall.

Period of Four Weeks ending	Sewage		Rainfall				
	Flow	Average Daily Flow	Davyhulme	Oldham Road	Platt Fields	Heaton Park	Godlee Observatory
	Gallons	Gallons per head	Inches	Inches	Inches	Inches	Inches
1926							
April 28th	1,190.542,000	56	1·41	1·27	1·07	1·52	1·402
May 26th	1,211,165,000	57	2·74	2·89	2·93	3·38	2 881
June 23rd	1,325,239,000	62	2·43	3·35	2·29	3·35	3 063
July 21st	1,159,469,000	55	1·62	1·56	1·78	1·71	1·600
August 18th	1,418,130,000	67	4·43	3·98	4·68	5·01	3·601
September 15th	1,324,148.000	62	2·80	2·59	2·63	2·74	2 654
October 13th	1,438,307.000	67	4·20	4·57	4·59	4·93	4·536
November 10th	1,408,702,000	66	3·50	3·00	3·14	3·23	2 818
December 8th	1,479.560,000	72	3·32	3·20	3·77	4·81	2·890
1927							
January 5th	1,181,472,000	56	1·57	1·47	1·30	1·80	1·317
February 2nd	1,604,623,000	76	3·21	3·62	2·97	3·30	3·386
March 2nd	1,313,482,000	62	2·31	2·27	2·05	2·35	2·053
March 30th	1,457,626,000	68	2·88	3·13	2·45	4·02	2·624
Totals for 52 weeks	17,512,465 000	63	36·42	36·90	35·65	42·15	34·825
Totals for 53 weeks ending March 31st, 1926	18,172.380,000	65	34·27	34·91	35·56	37·70	34·557

The number of days on which a measurable fall of rain (·01 inch or over) occurred during the 52 weeks was as follows :—

Davyhulme	206 days
Oldham Road	197 ,,
Platt Fields	204 ,,
Heaton Park	218 ,,
Godlee Observatory	192 ,,

Total Volume of Sewage Filtered.

The total volume of sewage dealt with by the various filter beds (primary contact and storm-water filters) and by the activated-sludge process during the year amounted to 9,268,710,000 gallons, or 53 per cent. of the total flow of sewage.

Of the total quantity thus dealt with, 5,830,280,000 gallons were treated on the secondary filter beds. This volume is equal to 63 per cent. of the primary effluent, or 33 per cent. of the total sewage flow.

Practically the whole of the unfiltered sewage received treatment in sedimentation tanks prior to its discharge to the canal.

Particulars of the quantities and composition of the raw sewage and unfiltered tank effluent are given in Tables II. and IV., together with comparative figures for the year ending March 31st, 1926.

The rate of the conversion of pail-closets during the past twenty-two years is given in the following table :—

Year	Number of Pail-closets converted during the year
1905	5,730
1906	6,534
1907	8,034
1908	10,984
1909	14,285
1910	12,580
1911	8,685
1912	7,429
1913	4,236
1914	1,429
1915	671
1916	227
1917	85
1918	12
1919	76
1920	9
1921	5
1922	32
1923	13
1924	33
1925	10
1926	4
1927	4

There are now comparatively few houses not served by the water-carriage system.

The amount of suspended matter in the sewage and various effluents together with the comparative figures for two preceding years, is given in Table XII.

SLUDGE DISPOSAL.

The total sludge production during the year was 221,546 tons, which is equal to 12·65 tons per million gallons sewage treated. Of this amount 195,325 tons were sent out to sea, 2,422 tons dealt with by the sludge presses and subsequently dried and sold as a fertiliser, and 23,799 tons of water or thin sludge were decanted from the sludge storage tanks (prior to loading the steamer), and discharged on to drainage beds.

During the year the sludge steamer "Joseph Thompson" made 181 voyages, an average of 3·48 trips per week. The total mileage covered was 23,530 (statute), an average of 453 miles per week. The total coal consumption was 2,033·4 tons, an average of 11·2 tons per trip.

Details of the cost of sludge disposal are given in Table II.

The demand for dried sewage sludge remains very poor.

TREATMENT OF THE SEWAGE IN SEDIMENTATION TANKS.

Sedimentation Tanks.

The six tanks referred to in the report for the year ending March, 1917, have been in operation as sedimentation tanks throughout the 12 months under observation.

The total flow through these tanks (water-holding capacity, 6,750,000 gallons) during the year amounted to 8,243,755,000 gallons, or 22,648,000 gallons per day.

In the following table particulars are given of the amount and character of the sludge removed from the individual tanks :—

Tank No.	Sludge Tons	Per cent. Water
6	22,770	89·4
7	30,203	88·0
8	22,132	87·7
9	21,775	88·3
10	21,175	87·7
11	22,050	88·7

The total quantity of sludge removed from the sedimentation tanks was 140,105 tons, or 17·0 tons per million gallons treated. The amount of sludge removed from these tanks is equal to 62 per cent. of the total tank sludge production.

Storm Beds.

As foreshadowed in the last annual report, these beds have been out of commission for the whole of the year under review. The media of several beds has been burnt *in situ* and subsequently removed, washed and rescreened.

The larger sized material has been employed in the renewal of the primary beds, and the finer material sold for making paths, tennis courts, and other purposes.

TREATMENT OF THE SEWAGE IN OPEN SEPTIC TANKS AND BACTERIA BEDS.

Open Septic Tanks.

There are now 10 tanks in operation as open septic tanks. The length of each tank is 300 feet, and the width and depth of five of the tanks is 100 feet and 6 feet (average) respectively ; the other four tanks are shallower, but of greater width, while No. 12 tank (a portion of which is occupied by the activated-sludge unit) is now only 66 feet wide.

The total holding capacity of the 10 tanks is about 12,000,000 gallons.

The total flow of sewage through the septic tanks during the year amounted to 9,268,710,000 gallons, or 25,463,000 gallons per day.

In the following table are given details of the amount and character of the sludge removed from the various tanks :—

Tank No.	Sludge Tons	Per cent. Water
1	1,573	85·1
2	4,981	84·9
3	11,161	87·7
4	12,971	88·9
5	12,529	84·6
12	4,365	91·2
13	9,513	88·0
14	6,035	87·3
15	10,632	88·5
16	3,347	86·9

The total sludge removed from the septic tanks was 77,107 tons, an average of 8·3 tons per million gallons.

Half-acre Primary Beds.

This filtration area has dealt with a total volume of tank effluent of 9,155,290,000 gallons at an average rate (over the whole area) of 547,000 gallons per acre per day, or 101 gallons per cubic yard per day, as compared with last year's figure of 669,000 gallons per acre, or 124 gallons per cubic yard per day.

This reduction in volume of tank effluent filtered is consequent on the adoption of the policy referred to in the last report with reference to the conservancy of the primary beds. This policy has scarcely been in force for a sufficient length of time to allow of a proper inference as to the resultant effect on the quality of the effluent obtained.

During the past year the washing, rescreening, and replacement of the filtering media of fourteen beds has been completed and the beds placed again in commission. These beds had been in operation for periods varying from five-and-a-half to five-and-three-quarter years since the date of their last renewal, and had meantime received from 5,605 to 6,736 fillings of tank effluent.

The average analytical returns, showing the results of treatment, together with the volumes of tank effluent dealt with, and comparative figures for the previous year, are given in Table V. The details of the usual maintenance expenditure and cost of renewal operations are given in Table II.

SECONDARY BEDS.

Experimental Half-acre Bed No. 10a.

This bed has now been in operation 22 years, and continues to receive 18 fillings of primary effluent per week, with suitable recuperative periods.

Reference to Table VI. will show that the volume of primary effluent treated was 53,124,000 gallons, an average of 292,000 gallons per acre per day, or 73 gallons per cubic yard per day. The analytical returns recorded in this table show that the usual high quality effluent has been maintained.

No. 1 Secondary Bed.

This bed continues to be operated as a contact bed, receiving usually 12 fillings of primary effluent per week.

The records given in Table VII. show the volume of primary effluent treated and the character of the resultant filtrate.

Second Contact Beds (Nos. 2 to 39).

The details of the construction of these beds are given in the Annual Report for the year ending March, 1909. The usual maintenance attention has been given to the surfaces of these beds, the cost of which is given in Table II. There has been no renewal work on this section of the filtration area during the year reported upon.

The quantities of primary effluent treated and the results of the analyses of the filtrates from the various sections of the secondary beds are given in Tables VIII. to XI., together with the comparative figures for the previous year.

SHIP CANAL WATER.

The results of the incubation test as applied to the canal water taken above the works outfall, together with a record of rainfall and air temperatures, are given in Diagram 1.

The condition of the canal water is largely governed by the incidence of rainfall and temperature, as will be seen by reference to this diagram.

During the first three months of the year (April, May, and June) the water was only occasionally slightly putrescent, but, as the result of the dry period which extended from the middle of June until towards the end of July and of the rise in temperature, the quality of the water deteriorated very seriously during the months of July and August. Following the heavy rainfall in August and September, there was a manifest improvement in the condition of the canal water despite a continuance of summer temperature. There was no set-back in the quality of water, which remained quite good throughout the autumn and winter months.

The results of the complete examination of the Ship Canal water above and below the outfall from the Davyhulme Works are recorded in Table XIII., together with the results for the preceding eight years. The results of the incubation test only are shown in Diagram 2.

SUMMARY OF RESULTS (DAVYHULME WORKS).

The following summary of the results of operation of the Davyhulme Works is submitted :—

Total sewage flow—

Main outfall .. 17,492,013,000
Davyhulme Parish, Point "E," 20,452,000
} = 17,512,465,000 gallons.

Total sludge removed .. .. .. = 221,546 tons.
= 12·6 tons per million gallons.

Total volume of sewage filtered (primary contact beds and storm beds) .. .. = 9,155,290,000 gallons.
= 52·3 per cent. of the total sewage flow.

Volume of sewage treated by the activated-sludge process .. .. = 113,420,000 gallons.
= 0·65 per cent. of the total sewage flow.

Total volume filtered by secondary beds .. .. = 5,830,280,000 gallons.
= 63·0 per cent. of the primary effluent.
= 33·0 per cent. of the total sewage flow.

TOTAL REVENUE COST (apart from Interest Charges and Repayment of Debt) :—

= £3 5s. 7·2d. per million gallons.

AVERAGE COST PER HEAD OF POPULATION—

		s.	d.
For year ending 30th March, 1927	=	1	6·2
For twenty-two years ending 30th March, 1927	=	1	2·5

RESULTS OF TREATMENT (expressed in grains per gallon).

Four hours oxygen absorption			Albuminoid ammonia		
Raw sewage	Average effluent, including unfiltered tank effluent	Percentage purification	Raw sewage	Average effluent, including unfiltered tank effluent	Percentage purification
7·50	3·79	49	·615	·30	51

In Table XIV. will be found particulars of the cost of sewage treatment at Davyhulme for the period 1896-1927, including the total outlay on sewage disposal works up to date, annual maintenance, and annual capital charge (payment of interest and repayment of debt), which has been estimated on the basis of 5 per cent. of the outlay to date. The costs are also given in terms of the amount per head of population. The percentage purification effected by the treatment of sewage during the different years is also shown, together with the estimated population connected to the sewers.

RESEARCH WORK—ACTIVATED SLUDGE PROCESS.

Demonstration Activated Sludge Plant.

Throughout practically the whole of the six years during which this plant has been in commission difficulty has been experienced in maintaining an adequate supply of compressed air, owing to the enforced use of old and inefficient compressors.

During the past year it became increasingly obvious that the compressors were incapable of supplying the minimum volume of air necessary for successful and economic operation of the plant, and, consequently, it was decided to reduce the capacity of the aeration chamber by using only one channel instead of three in conjunction with the sludge reaeration channel.

This modification was effected in June, 1926, and the plant has been in continuous operation since that date. It had been hoped by this means it would be possible to study the relationship of the proportion of air employed per unit area of the aeration chamber to the general economic operation of the process, but further failure of the air-compressing plant has rendered this impossible.

During the period under review a total volume of 104,949,000 gallons of settled sewage has been treated in the plant, at an average rate of 360,600 gallons per working day.

The portion of the aeration chamber in use and the reaeration channel have a combined capacity of 170,000 gallons, and, consequently, operating at the above rate, the mean detention period was rather more than 11 hours.

The following table of average analytical returns shows the results of treatment :—

Results in Grains per Gallon.

	Crude sewage	Settled sewage	Effluent
Four hours oxygen absorption	7·29	6·03	1·58
Free and saline ammonia	2·27	2·45	2·19
Albuminoid ammonia	·605	·48	·155
Oxidised nitrogen	—	—	·06
Putrescibility	—	—	28/287
Suspended solids..	19·6	7·4	2·1
Biochemical oxygen demand (Royal Commission test)	—	—	1·48

Having regard to the difficulty experienced in connection with the air supply to this plant these results may be considered as satisfactory. Under normal working conditions the effluents are well clarified, non-putrefactive, and comply with the standard recommended by the Royal Commission on Sewage Disposal in respect of the biochemical oxygen demand.

With the view of making a complete study of the economic relationship between air supply and period of detention (tank capacity) pending the construction of the activated-sludge units included in the extension scheme now in progress, this plant is now (September, 1927) being overhauled.

A modern air-compressing plant is being installed of sufficient capacity to enable one aeration chamber and the reaeration channel to be kept in commission, and the whole of the diffusers, which have been in use about six years, are being renewed.

It is hoped that when the plant is restarted under more favourable conditions than it has hitherto experienced it will be possible to obtain information which will be of service in the operation and control of the activated-sludge section of the new works.

Economics of the Process.

As foreshadowed in the last report, a prolonged investigation of the relative efficiencies of the "ridge and furrow" and "spiral flow" types of aeration chambers has been undertaken, and the scope of this enquiry has been extended by including in the general comparison a "central longitudinal furrow" type of aeration chamber.

A complete account of this work is given in Appendix I. to this report.

The possibility of the economic application of a "two-stage" process has also been carefully studied, and an account of this investigation is given in Appendix II. to this report.

Sludge Disposal.

No additional information has accrued during the year under review in relation to the economic dewatering of activated sludge by vacuum treatment (*vide* last year's report, pages 28 to 32), but a preliminary study has been made of the possibilities of the anaerobic fermentation of the sludge with recovery of the gaseous products as a means of sludge disposal.

Whilst the results are not complete enough to warrant publication, briefly it may be said that those so far obtained are generally corroborative of results published by German investigators, both in respect of the composition and volume of the gases evolved. They offer sufficient encouragement to proceed further with the investigation, especially having regard to the favourable situation for the complete utilisation of the high thermal value of the gaseous products of the site on which the necessary fermentation tanks would have to be constructed.

Contemporary with the laboratory studies at the Davyhulme Works, an investigation has been undertaken of the volume and composition of the gases evolved from the Emscher tanks at the Withington Works, which tanks it is proposed to utilise in larger scale trials of this possible means of sludge disposal.

Modification of the Process.

An enquiry in relation to the possibilities of "Aero-filter" treatment of the City sewage is in progress, and will be reported upon in due course.

Concluding Remarks.

Steady progress has been made during the year with the extension scheme at the Main Outfall Works, Davyhulme.

The new range of buildings at the entrance to the works, comprising various offices, store-rooms, stables, etc., has been completed, and is now in occupation.

Constructional work in connection with new detritus tanks and screening chambers is well advanced, and these works should be ready for equipment in the course of a few months.

The delay in the delivery of the cast-iron sludge main, consequent on the effect of the general strike last year, proved more serious than was anticipated, and on this account this work is not yet quite finished. The temporary sludge pumping station at Bent Lanes has been built and the necessary pumping machinery installed. Initiation of sludge disposal on land now only awaits the completion of a relatively short length of the pipe track from the Davyhulme Works to the Committee's land at Flixton and Carrington.

Constructional work on the activated-sludge units, included in the extension scheme, has been deferred pending the results of the investigation at the Withington Works, described in Appendix I. to this report. Modifications in the design of the new works consequent on the findings of this enquiry have yet to receive the approval of the Ministry of Health.

On behalf of the Rivers Committee,

F. J. West,
Chairman.

19th September, 1927.

APPENDIX I.

Activated Sludge Process.

Relative Efficiencies of Various Types of Aeration Chambers.

The performance during the period 1923-6 of the two activated-sludge units at the Withington Sewage Works, viz., (*a*) "ridge and furrow" unit and (*b*) "spiral flow" unit, led to the following conclusions :—

1. That economic operation of the "ridge and furrow" plant demanded a substantial air supply, in terms of volume of air per unit area of the aeration chamber, and when this condition is fulfilled sewage can be purified at a high rate with a practicable air consumption per gallon of sewage treated.
2. That sewage can be satisfactorily purified in the "spiral flow" plant with a sensibly lower air consumption per gallon of sewage treated, but this economy involves a substantial reduction in the rate of purification.

While these conclusions were more or less in accordance with preconceived ideas the detention period actually required in the "spiral flow" unit was greater than anticipated, and it became questionable whether the advantage held by this type of plant in respect of running costs was not more than outweighed by the increase in plant capacity required.

With the view of obtaining more precise information a closer investigation has been made of the relative efficiencies of the "ridge and furrow" and "spiral flow" types of aeration chambers, and the scope of this enquiry has been extended by including a study of a third type of aeration chamber, viz., "longitudinal furrow" design. For this purpose the floor of one of the two aeration chambers of the original "spiral flow" unit was reconstructed and the baffling arrangement modified.

The three types of aeration chambers may be briefly described as follows :—

(*a*) "Ridge and Furrow"—

Aeration channel, 490ft. long, 4ft. wide, and approx. 6ft. deep-water level to diffuser. The direction of the flow is reversed every hundred feet by baffle walls with side ports. The diffusers, occupying approx. one-eighth of the total superficial area, are placed in furrows running transversely to the direction of the flow. Water holding capacity, 62,000 gallons.

(*b*) "Spiral Flow"—

Aeration channel, 528ft. long, 6ft. 3in. wide, and 7ft. deep (approx.). Baffle walls, with side ports, at intervals of 35 feet. Direction of flow reversed every 176 feet. The diffusers, occupying approx. one-sixteenth of the total superficial area, are placed in continuous lines, on the flat floor of the chamber, alongside the curved footings of the longitudinal divisional walls, on one side of the channel only. Water holding capacity, 140,000 gallons.

(*c*) "Longitudinal Furrow"—

Aeration channel, 528ft. long, 6ft. 3in. wide, and approx. 7ft. deep-water level to diffuser. Under and over cross baffle walls are placed at intervals of 35 feet and the direction of the flow is reversed every 176 feet. The diffusers, occupying approx. one sixteenth of the total superficial area, are arranged in a continuous line down the centre of the channel, at the base of the longitudinal trough or furrow. Water holding capacity, 117,000 gallons.

Under the conditions prevailing it was not possible in this investigation to operate and to compare the performance of the three chambers in question simultaneously under exactly the same conditions, since the two latter units (*b*) and (*c*) are connected to one and the same settlement tank.

The method adopted therefore has been to use the original "ridge and furrow" chamber (*a*) as the standard plant and to compare its performance in turn with the other two chambers (*b*) and (*c*).

The usual practice in making these comparisons has been to operate the "ridge and furrow" unit (*a*) to its maximum effective capacity, employing what has been demonstrated to be the economic volume of air supply for this unit, viz., approx. 9 cubic feet per hour per square foot of tank area, and to compare the results so obtained in turn with those yielded by the other two units (*b*) and (*c*), also worked to their maximum effective capacity—as judged by the character of the sludge in the system and the quality of effluents produced—when operated with varying air supplies.

Since it was not possible to operate the three units simultaneously, some difficulty exists in strictly interpreting the results on account of the influence of variation of the strength of the sewage treated throughout the investigation. Moreover, it is also not easy to prepare a concise statement of the results obtained over the whole period covered by this enquiry, involving, as it does, a critical survey of a very large volume of analytical and other data, but it is believed that the following summarised statement gives as accurately as possible a true idea of the respective performance of the three units under trial.

A.—Comparison of the Ridge and Furrow Unit (*a*) with the Spiral Flow Unit (*b*).

1. *Excess air supply to spiral flow unit ; approx. 12 cubic feet free air per hour per square foot of tank area.*

(*a*) July 5th to 13th, 1926.

	Ridge and furrow	Spiral flow
Average daily volume of sewage (gallons)	246,000	388,000
Air consumption—cubic feet free air per gallon of sewage treated	1·67	2·65
Detention period in aeration chamber	6·05 hours	8·66 hours

Analytical Returns expressed in Grains per Gallon.

	Sewage	Effluents	
		Ridge and furrow	Spiral flow
Four hours oxygen absorption	3·55	·55	·52
Putrescibility	—	½/7	0/7
Free and saline ammonia	3·19	2·84	2·91
Albuminoid ammonia	·85	·18	·18
Nitrite and nitrate	—	·09	·135
Biochemical oxygen demand (Royal Commission Test)	—	1·70	2·07

Remarks :—

Towards the end of this period it was manifest that the spiral flow plant was capable of treating an increased volume of sewage.

(*b*) July 16th to 22nd, 1926.

	Ridge and furrow	Spiral flow
Average daily volume of sewage (gallons)	279,000	483,000
Air consumption	1·39	2·20
Detention period	5·33 hours	6·96 hours

Analytical Returns.

	Sewage	Effluents	
		Ridge and furrow	Spiral flow
Four hours oxygen absorption	3·39	·59	·61
Putrescibility	—	0/5	0/5
Free and saline ammonia	2·69	2·49	2·31
Albuminoid ammonia	·61	·17	·175
Nitrite and nitrate	—	·14	·52
Biochemical oxygen demand (Royal Commission Test)	—	·91	1·11

Remarks :—

Spiral flow plant still not reached maximum effective capacity as evidenced by superior condition of sludge and quality of effluent.

(*c*) July 27th to August 2nd, 1926.

	Ridge and furrow	Spiral flow
Average daily volume of sewage (gallons)	318,000	588,000
Air consumption	1·23	1·76
Detention period	4·68 hours	5·71 hours

Analytical Returns.

	Sewage	Effluents	
		Ridge and furrow	Spiral flow
Four hours oxygen absorption	2·74	·46	·46
Putrescibility	—	0/4	0/4
Free and saline ammonia	2·68	2·37	2·31
Albuminoid ammonia	·76	·135	·145
Nitrite and nitrate	—	·14	·15
Biochemical oxygen demand (Royal Commission Test)	—	1·38	1·11

Remarks :—

Results so far as quality of effluent and condition of sludge is concerned very nearly equal, but some evidence that the spiral flow unit could have treated a slightly increased volume of sewage.

(*d*) August 3rd to 18th, 1926.

	Ridge and furrow	Spiral flow
Average daily flow of sewage (gallons)	357,000	799,000
Air consumption	1·10	1·33
Detention period	4·17 hours	4·21 hours

Analytical Returns.

	Sewage	Effluents	
		Ridge and furrow	Spiral flow
Four hours oxygen absorption	2·81	·52	·52
Putrescibility	—	1/12	2/12
Free and saline ammonia	2·18	2·12	2·16
Albuminoid ammonia	·54	·14	·15
Nitrite and nitrate	—	·11	·08
Biochemical oxygen demand (Royal Commission Test)	—	1·31	1·03

Remarks :—

Generally speaking the quality of the two effluents was about equal during this period, but there was some evidence that the "spiral flow" unit could not have continued to operate indefinitely at the above rate.

Note slight increase in detention period and some 20 per cent. increase in air consumption for the "spiral flow" unit as compared with the standard "ridge and furrow" unit.

2. *Equal air supply ;* i.e., *9 cubic feet free air per hour per square foot of tank area.*

August 28th to September 20th, 1926.

	Ridge and furrow	Spiral flow
Average daily flow of sewage (gallons)	276,000	577,000
Detention period	5·39 hours	5·82 hours
Air consumption	1·45	1·58

Analytical Returns.

	Sewage	Effluents	
		Ridge and furrow	Spiral flow
Four hours oxygen absorption	2·88	·53	·58
Putrescibility	—	1/17	4½/17
Free and saline ammonia	2·46	2·48	2·44
Albuminoid ammonia	·63	·14	·145
Nitrite and nitrate	—	·11	·09
Biochemical oxygen demand (Royal Commission Test)	—	1·01	·85

Remarks :—

Despite slight increases in air supply and detention period, the results obtained from the " spiral flow " unit were definitely inferior to those yielded by the " ridge and furrow " unit.

B.—COMPARISON OF " RIDGE AND FURROW " UNIT (*a*) AND " LONGITUDINAL FURROW " UNIT (*c*).

1. *Excess air supply ; approx. 12 cubic feet per square foot per hour.*

October 22nd to December 12th, 1926.

	Ridge and furrow	Longitudinal furrow
Average daily volume of sewage (gallons)	453,000	1,127,000
Air consumption	0·87	0·96
Detention period	3·3 hours	2·5 hours

Analytical Returns.

	Sewage	Effluents	
		Ridge and furrow	Longitudinal furrow
Four hours oxygen absorption	2·54	·51	·61
Putrescibility	—	0/5	1½/5
Free and saline ammonia	1·92	1·76	1·78
Albuminoid ammonia	·61	·14	·155
Nitrite and nitrate	—	·09	·08
Biochemical oxygen demand (Royal Commission Test)	—	·56	·69

Remarks :—

Throughout the greater portion of this period the effluents were fairly equal in quality, but towards the end the "longitudinal furrow" effluent was distinctly inferior to that yielded by the "ridge and furrow" plant.

NOTE.—Although slightly increased air consumption, the detention period in the "longitudinal furrow" unit is appreciably less than in the "ridge and furrow" unit.

2. *Equal air supply ; 9 cubic feet air per square foot per hour.*

December 20th to January 17th, 1927.

(*a*)	Ridge and furrow	Longitudinal furrow
Average daily volume of sewage (gallons)	257,000	555,000
Air consumption	1·48	1·08
Detention period	5·8 hours	5·0 hours

Remarks :—

Effluents from "longitudinal furrow" unit (with lower air consumption and reduced detention period) were definitely inferior to those yielded by the "ridge and furrow" plant.

(*b*)	Ridge and furrow	Longitudinal furrow
Average daily volume of sewage (gallons)	358,000	435,000
Air consumption	1·07	1·41
Detention period	4·2 hours	6·5 hours

Remarks :—

In this series the effluent from the "ridge and furrow" unit (with lower air consumption and reduced detention period) were definitely inferior to those yielded by the "longitudinal furrow" unit.

(*c*)	Ridge and furrow	Longitudinal furrow
Average daily volume of sewage (gallons)	332,000	582,000
Air consumption	1·12	1·05
Detention period	4·5 hours	4·9 hours

Analytical Returns.

	Sewage	Effluents	
		Ridge and furrow	Longitudinal furrow
Four hours oxygen absorption	2·92	·46	·50
Putrescibility	—	0/10	2/10
Free and saline ammonia	1·85	1·83	1·87
Albuminoid Ammonia	·62	·135	·15
Nitrite and nitrate	—	·12	·11
Biochemical oxygen demand	—	·50	·57

Remarks :—

On the whole the effluents obtained during this series were very similar in character, although those yielded by the "ridge and furrow" held a slight advantage.

Note slight advantage in air consumption, but somewhat increased detention period for the "longitudinal furrow" as compared with standard "ridge and furrow" unit.

General Conclusions.

This investigation appears to have established :—

1. That, as operated at the Withington Works, the efficiencies, determined both by consideration of air consumption and detention period (effective capacity), of both the "ridge and furrow" and "longitudinal furrow" types of aeration chambers are definitely higher than that of the "spiral flow" type.

2. That there is little difference in the efficiency of the "ridge and furrow" and "longitudinal furrow" units, but, if anything, the advantage lies with the former unit. In this connection it should be remembered that the diffuser area in this unit is double that of the "longitudinal furrow" unit, and it appears reasonable to assume that this difference in construction may be sufficient to account for any small difference observed in their respective performances.

Whatever factors contribute to the differences noted in the relative efficiencies of the three plants, "short-circuiting" can be eliminated, inasmuch as elaborate "salt trials," in which the rate of progress of strong salt solution was traced throughout the aeration chambers, definitely established that there was sensibly less short-circuiting in the "spiral flow" and "longitudinal furrow" units than in the "ridge and furrow" plant.

Whilst the matter is subject to conjecture it would appear that adequate admixture and constant interchange of the sludge and sewage are important factors governing plant efficiency, and, of course, the effect of the varying diffuser ratio cannot be ignored.

From the point of view of constructional cost it is of interest to note that in the case of the "longitudinal furrow" unit, "salt trials" indicated that periodic "under and over" baffles were not essential for the prevention of short-circuiting, mere "curtain" baffle walls proving equally satisfactory.

APPENDIX II.

Activated Sludge Process—Withington Works.

Two-stage Process.

With the view of studying the economic possibilities of the application of a "two-stage" process to the purification of sewage, advantage was taken of the courtesy of Messrs. Activated Sludge Ltd., who kindly offered the loan of two small-scale model activated sludge plants of similar design and capacity.

Particulars of the plants, which were constructed in galvanised iron, are given below :—

Aeration Tanks—

"Spiral flow" type : one longitudinal division wall : ratio of diffuser area to total superficial area 1 : 20. Cross baffles with side ports after 4 feet. Direction of flow once reversed—

Length	24ft. 6in.
Width	1ft. 7in.
and depth (water level) ..	2ft. 9in.

Water holding capacity, 660 gallons.

Settlement Tanks—

Inverted pyramid type, fitted with central Clifford inlets. Water holding capacity, 200 gallons.

Reaeration Tanks—

The reaeration of the sludge was originally carried out in 50-gallon casks fitted with air-pipe and diffuser and central divisional wall. Water holding capacity, 40 gallons. Subsequently, in the first stage of the process, the reaeration chamber was enlarged at the expense of the aeration channel, so that finally the capacity of the reaeration chamber was increased to 370 gallons and the aeration chamber reduced to 330 gallons.

Standardisation of Plants—

Before proceeding with the study of the two-stage process it was necessary to ascertain the "effective" capacity of these plants when yielding non-nitrified and well-nitrified effluents respectively, for comparison with the results to be obtained later when operating in two stages.

In the first instance, therefore, the plants were operated independently—plant (*a*) with a non-nitrifying activated sludge and plant (*b*) with a sludge capable of yielding nitrified effluents.

The results obtained during this preliminary period are summarised in the following tabular statements :—

PLANT (*a*)—NON-NITRIFYING SLUDGE.

TABLE I.—*Particulars of Operation and Results of Treatment.*

Period	1	2	3	4
Date	May 10 to June 3	June 4 to 9	June 10 to 17	June 18 to 29

Analytical Results expressed in Grains per Gallon.

	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent
4 hours oxygen absorption	2·53	·51	3·46	·58	1·95	·42	3·11	·70
Putrescibility	—	0/14	—	1/4	—	0/6	—	3/6
Free and Saline ammonia	2·52	2·28	2·43	2·48	1·89	1·89	3·34	3·02
Albuminoid Ammonia	·55	·16	·55	·155	·46	·12	·74	·225
Nitrite } as NH_3 ..	—	·01	—	·01	—	·015	—	tr.
Nitrate	—	·19	—	·22	—	·26	—	·10
Character of sewage	Average strength		Average to strong		Diluted		Average to strong	
Average rate of flow—gallons per day	2,600		3,500		4,000		4,100	
Average detention period (aeration and reaeration)	6·5 hrs.		4·8 hrs.		4·2 hrs.		4·1 hrs.	
Remarks	Effluents entirely satisfactory		So long as the sewage remained of reasonable strength satisfactory effluents were obtained. Strong sewage treated at this rate produced bad effluents.		The sewage was frequently diluted with rainwater during this period, and satisfactory effluents under these conditions were readily produced.		When the sewage was of more than average strength the effluents were of poor quality, indicating that the plant during this period was much overworked.	

PLANT (*b*)—NITRIFYING SLUDGE.

TABLE II.—*Particulars of Operation and Results of Treatment.*

Period	1		2		3	
Date	May 22 to June 3		June 4 to June 9		June 10 to July 7	
Analytical Results expressed in Grains per Gallon.						
	Sewage	Effluent	Sewage	Effluent	Sewage	Effluent
4 hours oxygen absorption	2·60	·49	3·46	·63	2·82	·68
Putrescibility	—	0/4	—	0/4	—	0/20
Free and saline ammonia	3·01	·51	2·43	·85	2·88	·90
Albuminoid ammonia	·63	·12	·55	·135	·67	·175
Nitrite } as NH_3	—	·02	—	·045	—	·045
Nitrate }	—	1·29	—	1·22	—	1·09
Character of sewage	Average strength		Average to strong		More than average strength	
Average rate of flow—gallons per day	1,800		2,250		3,000	
Average detention period (aeration and reaeration)	9·3 hrs.		7·5 hrs.		5·6 hrs.	
Remarks	Entirely satisfactory results.				Flow varied from 1,900 to 3,900 gallons per day, according to strength of sewage. Nitrification well maintained.	

From the foregoing results it was concluded that for the production of a non-nitrified effluent of satisfactory quality the maximum effective capacity of the model plant when treating average strength sewage (Withington Works) was 3,500 gallons per day. At this rate the average detention period, aeration and reaeration chambers, was 4·8 hours, determined by the relation of sewage flow to total water holding capacity of aeration and reaeration chambers.

For the continued yield of well nitrified effluents the detention period required was 5·6 hours, and the effective capacity of the plant judged to be about 3,000 gallons per day when treating average strength sewage.

Having standardised the two model plants, they were arranged in series so as to form one purification plant having two sections, A and B.

The combination was so operated as to allow for (i.) the clarification and partial purification of the sewage in Section A, and (ii.) the further purification of the effluent from Section A to the point of nitrification in Section B.

Commencing on July 8th, 1926, with a clarifying sludge in Section A and a nitrifying sludge in Section B (both sludges in good condition) an initial moderate flow of sewage was gradually increased during this period (period (i.)), until approximately 4,500 gallons of sewage was treated daily.

For a period of 8 days (period (ii.)), an average flow of 4,500 gallons was maintained, and subsequently, after reactivating the sludge in both sections, an average flow of 6,000 gallons per day was dealt with for a period of nine days (Period iii.).

The results obtained were as follows :—

Period i.—Effluents from Section A were almost completely clarified and nitrification in Section B proceeded at a high rate.

Period ii.—The effluents from Section A were frequently cloudy, and difficulties arose with regard to settlement of the sludge in the settlement tank of this section, with the result that a portion of the sludge was passed forward to Section B. Nitrification, however, was well maintained in Section B, and, although the admixture of clarifying sludge with nitrifying sludge did not appear to be a desirable proceeding, the amount passed from A to B was not sufficient to interfere seriously with the nitrification.

Period iii.—Throughout this period Section A produced imperfectly clarified effluents and quantities of sludge passed forward to Section B. Ultimately both sludges were in poor condition ; showing that an average flow of 6,000 gallons per day could not be maintained.

Analytical returns covering the three periods are given below :—

TABLE III.

Period	1			2			3		
Date	July 8 to 14			July 15 to 22			July 27 to Aug. 4		
	Sew'ge	Effl. "A"	Effl. "B"	Sew'ge	Effl. *"A"	Effl. "B"	Sew'ge	Effl. *"A"	Effl. "B"
4 hours oxygen absorption	3·62	·63	·67	3·41	·88	·62	2·84	·83	·62
Putrescibility	—	2/5	0/4	—	3/6	0/6	—	4½/6	1½/6
Free and saline ammonia	3·30	2·93	·31	2·84	2·62	·92	2·75	2·63	1·52
Albuminoid ammonia	·73	·185	·18	·66	·235	·14	·72	·245	·155
Nitrite as NH_3	—	·025	·045	—	Nil	·05	—	Nil	·02
Nitrate	—	·15	1·59	—	·10	1·27	—	·09	·77
Character of sewage	Above average strength			Above average strength			Average to strong		
Average rate of flow—gallons per day	4,000			4,500			6,000 approx.		
Average detention period (aeration and reaeration)	8·4 hrs.			7·5 hrs.			5·6 hrs.		

* After settlement in laboratory for 1 hour and decantation.

It was evident from these results that, when operating in the manner described, the two-stage process could not compete successfully with the nominal method of applying the process, inasmuch as it was not possible in the two plants to continue to deal with twice the ascertained "standard" daily volume (3,000 gallons) of one plant, with the maintenance of well-nitrified effluents.

The chief difficulty was loss of condition of the "clarifying" sludge in Section A, due presumably to inadequate reconditioning, and consequently the plant was rearranged to allow of a longer period of reaeration at the expense of reduction in capacity of the aeration chamber (Section A only), and slightly improved results were obtained. High nitrification was maintained at a daily rate of 4,500 gallons per day, which was about equal to the performance of the plant (*b*) during the single stage trials. At higher rates, however, sludge passed forward in the effluent from Section A and the performance of the plant as a whole deteriorated.

Subsequently, as the plant did not allow of an increase in the capacity of the settlement tank attached to Section A, it was decided to try the effect of reducing the sewage flow through the plant, thus increasing the detention period (aeration and reaeration) in Section A. To counterbalance this the capacity of the secondary or nitrifying unit B was curtailed by operating only one-half the original aeration chamber, so that the total detention period in the plant as a whole was not sensibly affected.

The results obtained during this final trial are summarised in the following statement :—

Table IV.

Analytical Results expressed in Grains per Gallon.

Period	1			2		
Date	Sept. 9 to Oct. 4			Oct. 28 to Nov. 12		
	Sewage	Effluent "A"	Effluent "B"	Sewage	Effluent "A"	Effluent "B"
4 hours oxygen absorption	2·81	·70	·62	2·33	·78	·52
Putrescibility	—	3½/18	0/17	—	6½/12	0/12
Free and saline ammonia	2·37	1·73	·38	1·72	1·57	1·23
Albuminoid ammonia	·60	·185	·14	·54	·265	·14
Nitrite } as NH_3	—	·01	·04	—	tr.	tr.
Nitrate	—	·31	1·28	—	·14	·61
Character of sewage	Slightly above average strength			Below average strength		
Average rate of flow—gallons per day	2,900			4,500		
Average detention period	* 8·9 hours			* 6·0 hours		
Section A.—Total	* 5·8 hours			* 4·0 hours		
Detention in aeration chamber	† 1·0 hours			† 1·3 hours		
Period of reaeration of sludge	‡ 6·0 hours			‡ 6·0 hours		
Section B.—Total	* 3·1 hours			* 2·0 hours		

* Calculated from sewage flow and total volumetric capacity of aeration and reaeration chambers.

† Calculated from sewage flow plus return sludge and volumetric capacity of aeration chamber.

‡ Calculated from volume of return sludge and capacity of reaeration chamber.

Concluding Remarks.

The results of this investigation have demonstrated that—

1. The effluent resulting from the clarification of Withington sewage can be rapidly nitrified under suitable conditions of operation.
2. The inoculation of the nitrifying unit with sensible amounts of sludge from the first stage operation is inimical, and eventually prevents maintenance of active nitrification.

They appear also to warrant the further conclusion—

3. That no evidence was obtained of the superiority of the two-stage process, and, in fact, having regard to the manifest objections to a two-stage process by reason of the more complicated operation and control and increase in settlement tank requirements, the advantage lies definitely with the normal method of applying the process.

In this connection, however, it should be noted that operation on the small scale involves disadvantages, amongst which may be mentioned the difficulty of regulating precisely the flow of sewage, and more particularly in respect of the continuous operation of the air-lifts delivering the return sludge, unless a certain minimum volume of sludge is kept in circulation. Moreover, it is recognised that successful application of a two-stage process is dependent on adequate reconditioning of the "clarifying" sludge in the first stage, and in this respect it is appreciated that the conditions of the trial did not allow of a complete investigation of this aspect of the question, inasmuch as the variation in the proportion of the time of contact of the sludge with the sewage (aeration chamber) to the reaeration of the sludge alone (reconditioning) was strictly limited.

Thus, whilst it is felt, as the result of this enquiry, there is little likelihood of the economic application of a two-stage process to the treatment of the somewhat weak domestic sewage received at the Withington Works, it must not be taken that this finding will be of necessity generally applicable to the treatment of sewages of stronger or more complex character.

LIST OF TABLES AND DIAGRAMS.

Table I. Withington Works.—Total Expenditure.
,, II. Davyhulme Works.—Details of Total Expenditure.
,, III. Do. Summary of Cost of Treatment during the past four years.
,, IV. Do. Composition and Volume of Raw Sewage and Unfiltered Tank Effluent.
,, V. Do. Primary Beds — Quantity dealt with, and Composition of Filtrate.
,, VI. Do. Secondary Bed No. 10A—Quantity dealt with, and Composition of Filtrate.
,, VII. Do. Secondary Bed No. 1—Quantity dealt with, and Composition of Filtrate.
,, VIII. Do. Secondary Beds Nos. 5 to 19—Quantity dealt with, and Composition of Filtrate.
,, IX. Do. Secondary Beds Nos. 2 and 20 to 27—Quantity dealt with, and Composition of Filtrate.
,, X. Do. Secondary Beds Nos. 32 to 35 — Quantity dealt with, and Composition of Filtrate.
,, XI. Do. Secondary Beds Nos. 36 to 39 — Quantity dealt with, and Composition of Filtrate.
,, XII. Do. Suspended Solids in Sewage and Effluents.
,, XIII. Davyhulme Works.—Composition of Ship Canal Water above and below the Effluent Outlet.
,, XIV. Do. Particulars of Total Cost of Sewage Disposal, 1896–1927.
Diagram 1. Daily Examination of Ship Canal Water above Outfall (Incubation Test only), together with Rainfall and Temperature Records.
,, 2. Results of Examination of Ship Canal Water above and below Outfall, and of Average Effluent (Incubation Test only).

Table I.

WITHINGTON SEWAGE WORKS.

COST OF SEWAGE TREATMENT, 1926–1927.

TABLE 1.

	Labour			Materials, Services, &c.			Total		
	£	s.	d.	£	s.	d.	£	s.	d.
Screening	38	4	2	17	11	0	55	15	2
Settlement Tanks	28	10	6	2	12	11	31	3	5
Carriers	10	9	7	0	2	8	10	12	3
Activated Sludge Plant No. 1	21	13	8	2	7	7	24	1	3
Activated Sludge Plant No. 2	55	9	7	62	2	6	117	12	1
Emscher Tank	115	1	11	8	2	8	123	4	7
Primary Contact Beds	339	12	9	20	6	7	359	19	4
Secondary Contact Beds	231	14	3	21	15	0	253	9	3
Storm Beds	16	1	3	0	2	5	16	3	8
Valve Attendants	550	17	5	5	17	7	556	15	0
Grease Recovery	12	10	9	0	8	3	12	19	0
Power Charges	723	15	7	1,586	9	3	2,310	4	10
Disposal of Sludge	513	15	6	25	0	11	538	16	5
Laboratory	347	18	7	127	0	2	474	18	9
Storm-water Pump and Reservoir	28	4	1	5	0	4	33	4	5
Maintenance of Buildings	11	7	11	107	16	2	119	4	1
Roads, Fences, and Ditches	67	9	4	13	17	1	81	6	5
Repairs to River and Brook Banks	20	18	7	3	3	11	24	2	6
Land Cultivation	354	11	2	154	14	3	509	5	5
Rates and Taxes	—			926	8	1	926	8	1
Administration	308	2	9	113	2	8	421	5	5
New Motor for Activated Sludge Air Compressor	—			129	0	0	129	0	0
Tools and Sundries	40	11	1	58	0	9	98	11	10
Meadows	29	12	9	4	13	0	34	5	9
Experimental Activated Sludge Plants	7	3	0	13	1	10	20	4	10
Demonstration Activated Sludge Plant	1	17	3	1	18	1	3	15	4
Emscher Gas Experiments	22	17	11	11	9	7	34	7	6
Fire Insurance	—			11	9	9	11	9	9
Allowances to Sick Workmen	6	12	3	—			6	12	3
Additional Allowances to Superannuated Employees	42	1	0	—			42	1	0
Work for Outside Parties (Recovered)	3	11	1	4	7	5	7	18	6
Alterations to Activated Sludge Plant No. 2	239	0	5	111	3	9	350	4	2
	4,189	16	1	3,549	6	2	7,739	2	3

Credit :—	£	s.	d.	£	s.	d.
Sales of Farm Produce	253	0	5			
Sales of Grease	38	14	0			
Sales of Sludge and Sundry Materials	26	1	3			
Rents of Meadows	85	5	0			
Rents of Cottages and Land	49	13	1			
Motor transferred to Davyhulme Works	50	0	0			
Sundry Materials transferred to other Works	11	10	6			
				514	4	3
				£7,224	18	0

	£	s.	d.
Average cost per million gallons	4	18	10
Average cost per million gallons for year ended March 31st, 1926	4	12	11·7
Average cost per head of population connected to sewers	0	1	11·9
Average cost per head of population connected to sewers for year ended March 31st, 1926	0	2	0

NOTE.—In comparing these costs with the charge on the rates (see page 5), sums of £479 expended out of Renewal Fund and £110 (overlapping accounts) should be deducted.

DAVYHULME WORKS.

Table II.

TABLE II.—SHOWING QUANTITIES OF SLUDGE PRODUCED AND SEWAGE FLOW DEALT WITH BY BEDS.

SLUDGE

Period of 3 Months ending	Sludge Produced	Trips run by Steamer	Refuse from Screens
1926	Tons		Tons
June 30th	64,575	53	1,261
September 29th	52,542	46	1,413
December 29th	50,350	40	1,183
1927			
March 30th	54,079	42	1,228
Total for 52 weeks ending March 30th, 1927	221,546	181	5,085
Average per week (52 weeks)	4·261	3·48	97·79
Average per million gallons	12·65	...	0·29
		Average per week	
Average for 53 weeks ending March 31st, 1926	12·99	3·75	0·27
Average for 52 weeks ending March 25th, 1925	11·97	4·23	0·21

Memo.—195,325 tons deposited at sea; 23,799 tons water decanted from sludge tanks; and 2,422 tons dealt with by presses.

	£	s.	d.
Cost per ton of Refuse Screened from Sewage	0	7	6·2
Cost per 1,000 tons of Sludge for Tank Cleaning	4	16	9·3
Cost for each trip run by Steamer (or 1/4 6 per ton of Sludge).	74	18	8

FILTRATION.

	Gallons.	Gallons.
Septic Tank Effluent dealt with by Primary Beds (46 acres):—		
Quarter ending June 30th, 1926	2,420,800,000	
,, ,, September 29th, 1926	2,327,325,000	
,, ,, December 29th, 1926	2,251,255,000	
,, ,, March 30th, 1927	2,155,910,000	
		9,155,290,000
Unfiltered Tank Effluent:—		
Quarter ending June 30th, 1926	1,545,842,000	
,, ,, September 29th, 1926	1,970,536,000	
,, ,, December 29th, 1926	2,214,280,000	
,, ,, March 30th, 1927	2,513,097,000	
		8,243,755,000
Activated Sludge Tank (No. 12):—		
Quarter ending June 30th, 1926	18,837,000	
,, ,, September 29th, 1926	35,544,000	
,, ,, December 29th, 1926	38,962,000	
,, ,, March 30th, 1927	20,077,000	
		113,420,000
Total Sewage Flow:—		
Quarter ending June 30th, 1926	3,985,479,000	17,512,465,000
,, ,, September 29th, 1926	4,333,405,000	
,, ,, December 29th, 1926	4,504,497,000	
,, ,, March 30th, 1927	4,689,084,000	
Effluent from Primary Beds, dealt with by Secondary Beds:—		
Quarter ending June 30th, 1926	1,416,549,000	
,, ,, September 29th, 1926	1,499,524,000	
,, ,, December 29th, 1926	1,462,143,000	
,, ,, March 30th, 1927	1,452,064,000	
		5.830,280,000

AVERAGE PER DAY.

	52 weeks ended March 30th, 1927	53 weeks ended March 31st, 1926	52 weeks ended March 25th, 1925
	Gallons.	Gallons.	Gallons.
Primary Beds	25,152,000	30,794,000	35,843,000
Storm Beds	...	3,846,000	2,308,000
Unfiltered Tank Effluent	22,648,000	13,904,000	17,564,000
Activated Sludge Tank	311,000	438,000	671,000
Total Sewage Flow	48,111,000	48,982,000	56,386,000
Secondary Beds	16,017,000	15,458,000	16,142,000

DETAILS OF EXPENDITURE, April, 1926—March, 1927.

	£	s	d	£	s.	d.
Screening Sewage				1,912	7	11
Tank Cleaning				1,074	4	0
Pumping Sludge and Sludge Tanks				609	9	6
Sludge Pressing				438	8	5
Sludge Drying, Grinding, etc.				784	10	1
Sludge Steamer—Salary and Wages				4,343	10	9
,, Coal and Water				1,279	1	1
,, Ship's Stores				481	9	10
,, Insurance				1,379	15	6
,, Canal Tolls				500	0	0
,, Pilot Licences				21	0	0
,, Repairs—Loading Pipe	60	17	8			
Steamer	3,087	5	0			
	3,148	2	8			
Less Damage Repairs refunded	590	1	5			
				2,558	1	3
Primary Beds—Valvemen, Cleaning, etc.				5,431	6	11
Secondary Beds— ,, ,,				3,412	14	3
Other Maintenance Charges				1,084	5	3
Renewal of Beds—Loading, Washing, etc.				5,231	10	11
,, Refuse Tip				438	1	2
,, Filtering Media				906	15	11
,, Locomotive and Waggon Charges				4,645	1	5
,, Tramway Work and Maintenance				819	13	3
,, Repairs, etc., to Washing Plant and Steam Navvies				776	6	1
,, Sundry Labour, Plant, etc.	900	6	7			
,, *Less* Hire of Plant	56	5	0			
				844	1	7
Power Charges				2,220	9	2
Locomotive and Waggon Charges				1,161	5	3
Tramway Work and Maintenance				212	10	9
Repairs to Roads and Footpaths				368	12	1
Recovery of Sewage Grease				222	12	6
Laboratory Expenses				1,934	8	11
Rents, Rates, Taxes, and Insurance				2,661	6	9
Telephone Rents, etc.				43	9	8
Stationery				204	9	1
Legal and Professional Services				6	9	6
Whitley Council Expenses				18	3	8
Middleton Sewage Works	31	0	6			
Less Rent	20	0	0			
				11	0	6
Maintenance and Repair of Buildings				494	6	10
Erection of Saw Mill				128	10	8
Repairs to Unloading Wharf				260	1	8
New Shed at Flixton				107	15	3
New Valvemen's Cabins (completed)				54	13	5
Sundry Plant and Repairs				335	19	0
Activated Sludge Plant				216	15	2
Expenses *re* Extension of Works				613	19	4
Expenses *re* "Oliver Filter"				31	0	5
Gauging Sewage Flow				14	4	10
Salaries of Staff				2,645	18	3
Sick Pay Allowances				187	17	1
Accident Allowances and Sundries				18	16	7
Additional and Compassionate Allowances				86	17	3
Gas, Electric Lighting, and Water				370	16	7
Expenses *re* Davyhulme Parish Sewage				29	11	9
Diversion of Footpath				472	17	7
Farm Labour, Seeds, Implements, etc.				1,454	11	8
Superintendence, Timekeeping, and Sundry Work				1,685	15	11
Sundries not Classified				421	16	6
				60,668	18	8
Cr.						
Sale of Dried Sewage Manure and Screenings	895	14	5			
,, Farm Produce, Grease, and Scrap Metal	1,761	19	1			
,, Red Ash	120	7	2			
Rents of Lands	278	10	3			
Sundries	169	14	3			
				3,226	5	2
				£57,442	13	6

	£	s.	d.
Average per week (52 weeks)	1,104	13	4
,, million gallons	3	5	7·2

NOTE—A Contribution of £11,271 8s. 7d. from the Local Authorities of Stretford, Middleton, Audenshaw, and Barton is not included in the above Statement.

DAVYHULME WORKS.

TABLE III.—COMPARATIVE ANNUAL COSTS, ETC., PERIOD 1923–24 to 1926–27.

Year	Total			Sludge produced	Trips run by Steamer	Refuse from Screens	Sewage flow	Cost per Million Gallons			Average Population connected to Sewers	Cost per Head		
	£	s.	d.	Tons		Tons	Gallons	£	s.	d.		£	s.	d.
1923–24	68,381	17	8	227,214	208	5,011	17,269,264,000	3	19	2·4	748,300	0	1	9·9
1924–25	52,771	9	8	245,684	220	4,291	20,524,654,000	2	11	5·1	750,500	0	1	4·9
1925–26	57,268	17	7	236,101	199	4,925	18,172,380,000	3	3	0.4	754,000	0	1	6·2
1926–27	57,442	13	6	221,546	181	5,085	17,512,465,000	3	5	7·2	757,000	0	1	6·2

Note.—In comparing this year's Works cost with the charge on the Rates (see page 5), £340, unexpended on Renewals Account and £45 overlapping Accounts should be added, and the following item deducted, viz:— £11,271 8s. 7d. being the Contributions from the various outside Local Authorities, (see Table II).

Table IV.

DAVYHULME WORKS.

TABLE IV.—SHOWING THE CHEMICAL COMPOSITION OF THE RAW SEWAGE (AVERAGE OF HOURLY SAMPLES) AND OF THE UNFILTERED TANK EFFLUENT, TOGETHER WITH THE RELATIVE VOLUMES OF EACH.

DATE	4 Hours oxygen absorption			Free and saline ammonia			Albuminoid ammonia			Nitrite (in terms of NH_3)	Nitrate (in terms of NH_3)	Chloride (in terms of Cl.)			INCUBATION TEST					TOTAL QUANTITY Gallons			Percentage of total flow dealt with on the filtration areas and by the activated sludge process
															3 Minutes oxygen absorption				Putrescibility				
															Before incubation			After incubation					
Quarter ending	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Tank effluent	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Tank effluent	Tank effluent	Total raw sewage	Davyhulme Parish sewage	Tank effluent (Unfiltered)	
1926																							
June 30th	8·14	3·54	6·57	2·35	1·99	2·53	·64	·47	·515	Trace	·07	13·0	4·2	12·8	3·65	1·28	2·97	4·31	59/59	3,985,479,000	4,230,000	1,545,842,000	61·2
September 29th	7·26	3·38	5·52	2·19	1·84	2·19	·715	·525	·53	Trace	·06	12·7	4·4	11·8	3·40	1·35	2·61	4·35	64/64	4,333,405,000	4,643,000	1,970,536,000	54·5
December 29th	6·95	2·44	5·65	2·08	1·35	2·13	·60	·37	·475	·01	·11	12·0	4·3	11·0	3·16	·95	2·57	3·45	62½/63	4,504,497,000	6,247,000	2,214,280,000	50·8
1927																							
March 30th	7·65	2·75	6·10	1·92	1·86	1·78	·52	·40	·39	·015	·15	12·6	3·7	11·1	3·41	1·03	2·82	3·36	63/64	4,689,084,000	5,332,000	2,513,097,000	46·4
Average	7·50	3·03	5·96	2·14	1·76	2·16	·62	·44	·475	·01	·10	12·6	4·2	11·7	3·41	1·15	2·74	3·87	248½/250	17,512,465,000	20,452,000	8,243,755,000	52·9
Average for year ending March 31st, 1926	7·50	1·89	6·53	2·14	1·15	2·16	·665	·26	·54	.01	·12	12·8	3·5	13·0	3·38	.73	2·95	4·04	235/239	18,172,380,000	16,556,000	5,158,410,000	71·6

Table V.

DAVYHULME WORKS.

PRIMARY BEDS.—Series I., II., III., and IIIa.

TABLE V.—SHOWING QUANTITY DEALT WITH, AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

DATE	4 Hours oxygen absorption						Free and saline ammonia						Albuminoid ammonia					
Quarter ending	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.
1926 June 30th	8·14	7·33	4·00	3·76	6·81	3·43	2·35	2·20	1·94	2·12	2·74	2·20	·64	·455	·265	·255	·46	·275
September 29th	7·26	6·15	3·60	3·34	4·93	2·36	2·19	2·17	1·77	2·05	2·57	2·14	·715	·445	·255	·25	·49	·27
December 29th	6·95	6·35	3·61	3·30	5·52	2·24	2·08	2·22	1·95	1·86	2·36	1·92	·60	·405	·24	·225	·46	·22
1927 March 30th	7·65	6·42	3·51	3·27	6·06	2·84	1·92	2·17	1·84	1·83	2·12	1·85	·52	·375	·22	·22	·385	·21
Average	7·50	6·56	3·68	3·42	5·83	2·72	2·14	2·19	1·88	1·97	2·45	2·03	·62	·42	·215	·235	·45	·245
Average for year ending March 31st, 1926	7·50	6·39	3·43	2·96	6·08	2·77	2·14	2·15	1·85	1·86	2·45	2·12	·665	·47	·26	·23	·485	·245
Purification effected Calculated on tank effluent			44%	48%		53%									42%	44%		46%
Corresponding purification for year ending March 31st, 1926			46%	54%		54%									45%	51%		49%
Calculated on raw sewage			51%	54%		64%									65%	62%		60%
Corresponding purification for year ending March 31st, 1926			54%	61%		63%									61%	65%		63%

DATE	Nitrite (in terms of NH_3) Series			Nitrate (in terms of NH_3) Series			Chloride (in terms of Cl)					
Quarter ending	I.	II.	III. and IIIa.	I.	II.	III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.
1926 June 30th	·01	Tr.	·01	·07	·07	·07	13·0	14·4	13·3	13·3	11·5	10·9
September 29th	Tr.	Nil	·01	·05	·05	·06	12·7	13·1	12·0	12·2	11·1	10·2
December 29th	·015	·015	·01	·09	·10	·16	12·0	13·2	12·4	12·5	10·4	9·1
1927 March 30th	·025	·015	·015	·12	·12	·16	12·6	14·0	12·3	12·4	10·8	9·5
Average	·015	·01	·01	·08	·09	·11	12·6	13·7	12·5	12·6	11·0	9·9
Average for year ending March 31st, 1926	·01	·01	·015	·10	·10	·13	12·8	13·4	12·5	12·5	11·5	10·8

DATE	INCUBATION TEST: 3 Minutes oxygen absorption, Before incubation						After incubation, Series			Putrescibility, Series		
Quarter ending	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	I.	II.	III. and IIIa.	I.	II.	III. and IIIa.
1926 June 30th	3·65	3·48	2·16	2·01	3·30	1·76	2·74	2·68	2·46	10/11	10½/11	13/13
September 29th	3·40	3·05	1·88	1·75	2·48	1·21	2·73	2·55	1·85	13/13	13/13	13/13
December 29th	3·16	3·06	1·95	1·75	2·74	1·16	2·45	2·22	1·53	11/13	11/13	8½/13
1927 March 30th	3·41	3·10	1·89	1·74	2·90	1·48	2·30	2·13	1·81	11/13	11½/13	12½/13
Average	3·41	3·17	1·97	1·81	2·86	1·40	2·56	2·40	1·91	45/50	46/50	47/52
Average for year ending March 31st, 1926	3·38	3·06	1·80	1·54	2·98	1·44	2·38	2·01	1·81	46/52	42½/52	41½/51

DATE	Quantity dealt with (Gallons) Series			Average quantity dealt with: Per acre per day (Gallons) Series			Per cubic yard per day (Gallons) Series		
Quarter ending	I.	II.	III. and IIIa.	I.	II.	III. and IIIa.	I.	II.	III. and IIIa.
1926 June 30th	1,083,620,000	362,600,000	974,580,000	595,000	664,000	535,000	110	122	99
September 29th	1,073,900,000	367,300,000	886,125,000	590,000	673,000	487,000	109	125	90
December 29th	872,400,000	369,800,000	1,009,055,000	479,000	677,000	514,000	89	125	103
1927 March 30th	778,880,000	346,100,000	1,030,930,000	425,000	634,000	566,000	79	117	[illegible]
Average	3,808,800,000	1,445,800,000	3,900,69[illegible]	523,000	662,000	536,000	97	[illegible]	[illegible]
Average for year ending March 31st, 1926	4,865,155,000	1,622,095,000	4,937,[illegible],000	656,000	729,000	665,000	121	13[illegible]	[illegible]

Table VI.

DAVYHULME WORKS

HALF ACRE SECOND CONTACT BED—No. 10A.

TABLE VI.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

Date	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test						Total quantity dealt with	Average quantity dealt with	
													3 Minutes oxygen absorption				Putrescibility				
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
1926 June 30th	3·87	1·55	2·07	1·25	·305	·13	Nil	·02	·05	·62	11·4	11·1	1·98	·72	2·79	·59	13/13	0/10	13,680,000	150,000	75
September 29th	3·81	1·52	1·86	1·06	·305	·145	Trace	·03	·05	·62	11·4	11·8	2·01	·72	2·95	·61	13/13	0/9	12,312,000	135,000	68
December 29th	3·66	1·19	1·82	·94	·28	·115	·01	·015	·10	·90	10·9	10·1	2·01	·56	2·56	·41	10/13	0/10	13,680,000	150,000	75
1927 March 30th	3·85	1·26	1·78	·89	·22	·10	·02	·02	·13	·92	12·0	10·5	2·02	·59	2·33	·50	8/13	0/10	13,452,000	148,000	74
Average	3·80	1·38	1·88	1·04	·28	·12	·01	·02	·08	·77	11·4	10·9	2·01	·65	2·66	·53	44/52	0/39	53,124,000	146,000	73
Average for year ending March 31st, 1926	3·72	1·35	1·81	·99	·29	·13	·01	·015	·10	·85	11·7	11·4	1·97	·65	2·51	·56	46½/50	0/39	53,124,000	143,000	72
Purification effected Calculated on primary effluent		64%				57%															
Corresponding purification for year ending March 31st, 1926		64%				55%															
Calculated on raw sewage		82%				81%															
Corresponding purification for year ending March 31st, 1926		82%				80%															

No. 1 SECONDARY BED

TABLE VII.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

Date	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test						Total quantity dealt with	Average quantity dealt with	
													3 Minutes oxygen absorption				Putrescibility			Per day	Per cubic yard per day
													Before incubation		After incubation						
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 30th, 1926	4·13	1·85	2·24	1·45	·315	·16	Nil	·02	·06	·39	12·1	12·1	2·19	·90	3·16	·86	25/25	2/25	56,160,000	617,000	96
September 29th, 1926	3·43	1·82	2·11	1·37	·33	·195	Trace	·025	·06	·35	11·1	11·8	1·82	·95	2·97	1·00	25½/26	5½/22	48,600,000	534,000	83
December 29th, 1926	3·45	1·67	1·97	1·30	·275	·155	·015	·025	·09	·54	10·7	11·0	1·89	·81	2·50	·82	22/26	5/26	56,160,000	617,000	96
March 30th, 1927 ...	3·52	1·66	1·86	1·19	·23	·13	·01	·015	·11	·63	11·3	11·9	1·82	·82	2·27	·74	22½/26	2/21	47,160,000	518,000	81
Average	3·63	1·75	2·05	1·33	·29	·16	·01	·02	·08	·48	11·3	11·7	1·93	·87	2·73	·86	95/103	14½/94	208,080,000	572,000	89
Average for year ending March 31st, 1926	3·72	1·88	2·05	1·37	·31	·175	·01	·02	·10	·50	11·8	12·2	2·00	·95	2·82	·93	92/100	12½/95	215,640,000	581,000	91

Purification effected.		4 Hours oxygen absorption	Free and saline ammonia	Albuminoid ammonia
	Calculated on primary effluent	52%		45%
	Corresponding purification for year ending March 31st, 1926	49%		44%
	Calculated on raw sewage	77%		74%
	Corresponding purification for year ending March 31st, 1926	75%		74%

DAVYHULME WORKS.

Table VIII.

SECOND CONTACT BEDS—Nos. 5 to 19 (inclusive).

TABLE VIII.—SHOWING QUANTITIES DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test						Quantity dealt with	Average quantity dealt with	
													3 Minutes oxygen absorption				Putrescibility				
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 30th, 1926 ...	4·13	1·77	2·24	1·32	315	·155	Nil	·02	·06	·41	12·1	11·8	2·19	·85	3·16	·84	25/25	3/25	485,466,000	5,335,000	88
September 29th, 1926	3·43	1·50	2·11	1·24	·33	·17	Trace	·025	·06	·43	11·1	11·7	1·82	·73	2·97	·72	25½/26	4½/26	507,420,000	5,576,000	92
December 29th, 1926	3·45	1·54	1·97	1·18	·275	·14	·015	·02	·09	·58	10·7	10·5	1·89	72	2·50	·69	22/26	0/26	436,317,000	4,795,000	79
March 30th, 1927 ...	3·52	1·50	1·86	1·11	·23	·12	·01	·02	·11	·71	11·3	11·3	1·82	·73	2·27	·73	22½/26	2/26	469,947,000	5,164,000	85
Average	3·63	1·58	2·05	1·21	·29	·145	·01	·02	·08	·53	11·3	11·3	1·93	·76	2·73	·75	95/103	9½/103	1,899,150,000	5,217,000	86
Average for year ending Mar. 31st, 1926	3·72	1·62	2·05	1·24	·31	·155	·01	·015	·10	·54	11·8	11·7	2·00	·78	2·82	·71	92/100	7½/100	1,985,508,000	5,352,000	88
Purification effected	Calculated on primary effluent	56%				50%															
	Corresponding purification for year ending March 31st, 1926	56%				50%															
	Calculated on raw sewage	79%				77%															
	Corresponding purification for year ending March 31st, 1926	78%				77%															

Table IX.

DAVYHULME WORKS.

SECOND CONTACT BEDS—Nos. 2 and 20 to 27 (inclusive).

TABLE IX.—SHOWING QUANTITIES DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		INCUBATION TEST						QUANTITY DEALT WITH	AVERAGE QUANTITY DEALT WITH	
													3 Minutes oxygen absorption				Putrescibility			Per day	Per cubic yard per day
													Before incubation		After incubation						
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 30th, 1926	4·13	1·62	2·24	1·28	·315	·15	nil.	·02	·06	·49	12·1	12·1	2·19	·78	3·16	·69	25/25	1½/25	206,943,000	2,274,000	69
September 29th, 1926	3·43	1·62	2·11	1·14	·33	·18	Trace	·025	·06	·42	11·1	11·8	1·82	·81	2·97	·77	25½/26	3/26	203,352,000	2,235,000	68
December 29th, 1926	3·45	1·37	1·97	1·03	·275	·125	·015	·025	·09	·63	10·7	10·7	1·89	·64	2·50	·53	22/26	0/26	223,248,000	2,453,000	74
March 30th, 1927 ...	3·52	1·50	1·86	1·07	·23	·12	·01	·015	·11	·70	11·3	11·6	1·82	·75	2·27	·69	22½/26	0/26	216,108,000	2,375,000	72
Average	3·63	1·53	2·05	1·13	·29	·14	·01	·02	·08	·56	11·3	11·6	1·93	·75	2·73	·67	95/103	4½/103	849,651,000	2,334,000	71
Average for year ending March 31st, 1926 ...	3·72	1·57	2·05	1·19	·31	·155	·01	·02	·10	·58	11·8	12·1	2·00	·76	2·82	·69	92/100	3½/100	879,055,000	2,369,000	72
Purification effected Calculated on primary effluent		58%				52%															
Corresponding purification for year ending March 31st, 1926		58%				50%															
Calculated on raw sewage		80%				77%															
Corresponding purification for year ending March 31st, 1926		79%				77%															

Table X.

DAVYHULME WORKS.

SECOND CONTACT BEDS—Nos. 32 to 35.

TABLE X.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test						Quantity dealt with	Average quantity dealt with	
													3 Minutes oxygen absorption				Putrescibility				
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 30th, 1926 ……	3·87	1·61	2·07	1·09	·305	·125	Nil	·025	·05	·55	11·4	10·9	1·98	·78	2·79	·65	13/13	0/9	174,000,000	1,912,000	78
September 29th, 1926	3·81	1·25	1·86	·76	·305	·125	Trace	·025	·05	·75	11·4	11·1	2·01	·59	2·95	·48	13/13	0/13	238,680,000	2,623,000	107
December 29th, 1926	3·66	1·39	1·82	·86	·28	·12	·01	·02	·10	·97	10·9	10·4	2·01	·66	2·56	·56	10/13	0/13	238,680,000	2,623,000	107
March 30th, 1927 …	3·85	1·57	1·78	·97	·22	·11	·02	·015	·13	·79	12·0	10·9	2·02	·76	2·33	·72	8/13	1/13	238,680,000	2,623,000	107
Average ………	3·80	1·46	1·88	·92	·28	·12	·01	·02	·08	·77	11·4	10·8	2·01	·70	2·66	·60	44/52	1/48	890,040,000	2,445,000	99
Average for year ending March 31st, 1926 …	3·72	1·34	1·81	·88	·29	·13	·01	·015	·10	·81	11·7	10·8	1·97	·65	2·51	·51	46½/50	0/45	842,520,000	2,271,000	92
Purification effected: Calculated on primary effluent		62%				57%															
Purification effected: Corresponding purification for year ending March 31st, 1926.		64%				55%															
Purification effected: Calculated on raw sewage		81%				81%															
Purification effected: Corresponding purification for year ending March 31st, 1926.		82%				80%															

SECOND CONTACT BEDS—Nos. 36–39 (INCLUSIVE).

TABLE XI.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		INCUBATION TEST						QUANTITY DEALT WITH	AVERAGE QUANTITY DEALT WITH	
													3 Minutes oxygen absorption				Putrescibility			Per day	Per cubic yard per day
													Before incubation		After incubation						
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 30th, 1926......	3·87	1·60	2·07	·90	·305	·12	nil.	·02	·05	·77	11·4	11·2	1·98	·76	2·79	·67	13/13	0/11	235,620,000	2,589,000	114
September 29th, 1926	3·81	1·30	1·86	·77	·305	·125	Trace	·025	·05	·70	11·4	11·0	2·01	·60	2·95	48	13/13	0/13	238,680,000	2,623,000	116
December 29th, 1926	3·66	1·40	1·82	·85	·28	·12	·01	·02	·10	·99	10·9	10·3	2·01	·67	2·56	·53	10/13	0/13	238,680,000	2,623,000	116
March 30th, 1927 ...	3·85	1·58	1·78	·96	·22	·115	·02	·01	·13	·78	12·0	10·7	2·02	·78	2·33	·72	8/13	1/12	230,520,000	2,533,000	112
Average	3·80	1·47	1·88	·87	·28	·12	·01	·02	·08	·81	11·4	10·8	2·01	·70	2·66	·60	44/52	1/49	943,500,000	2,592,000	114
Average for year ending March 31st, 1926 ...	3·72	1·36	1·81	·85	·29	·12	·01	·02	·10	·85	11·7	10·8	1·97	·66	2·51	·52	46½/50	0/40	760,920,000	2,051,000	90
Purification effected	Calculated on primary effluent	61 %				57 %															
	Corresponding purification for year ending March 31st, 1926	63 %				59 %															
	Calculated on raw sewage	80 %				81 %															
	Corresponding purification for year ending March 31st, 1926	82 %				82 %															

Table XII.

TABLE XII.—SHOWING THE AMOUNT OF SUSPENDED SOLIDS CONTAINED IN THE SEWAGE, TANK EFFLUENTS, AND FILTRATES.

	RESULTS EXPRESSED IN GRAINS PER GALLON								
	Average for the year ending March 30th, 1927			Average for the year ending March 31st, 1926			Average for the year ending March 25th, 1925		
	Mineral	Organic and Volatile	Total	Mineral	Organic and Volatile	Total	Mineral	Organic and Volatile	Total
Sewage	8·0	12·5	20·5	8·7	13·8	22·5	7·3	13·0	20·3
Open Septic Tank Effluent (East)	2·6	3·9	6·5	3·4	5·2	8·6	2·8	5·0	7·8
Series I. (Beds 13 to 52)	1·5	2·5	4·0	2·1	3·4	5·5	1·7	3·4	5·1
Do. II. (Beds 1A to 10)	2·2	3·0	5·2	2·6	3·6	6·2	1·8	3·7	5·5
Open Septic Tank Effluent (West)	2·6	4·2	6·8	3·0	5·0	8·0	2·8	5·3	8·1
Series III. and IIIA. (Beds 53 to 92)	1·7	2·4	4·1	1·6	2·8	4·4	1·5	3·2	4·7
Unfiltered Tank Effluent	4·0	6·0	10·0	4·8	7·9	12·7	5·0	7·9	12·9
Second Contact Bed (No. 10A)	·7	1·0	1·7	·9	1·4	2·3	·7	1·6	2·3
Do. do. (No. 1)	·7	1·0	1·7	·9	1·4	2·3	·8	1·3	2·1
Do. do. (Nos. 2 to 27 inclusive)	·7	1·0	1·7	1·1	1·5	2·6	·8	1·4	2·2
Do. do. (Nos. 32 to 39 inclusive)	·9	1·0	1·9	·9	1·2	2·1	·8	1·5	2·3

TABLE XIII.—RESULTS OF EXAMINATION OF THE SHIP CANAL WATER ABOVE AND BELOW THE OUTFALL.

DATE	Four hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Chloride (in terms of Cl.)		Incubation Test							
									3 Minutes oxygen absorption				Putrescibility		Percentage rise in the 3 minutes oxygen absorption test after incubation	
									Before incubation		After incubation					
MONTH	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
April 1926	1·18	1·70	·67	·95	·125	·155	7·8	8·8	·51	·84	·67	1·07	4½/7	5½/7	—	—
May ,,	1·08	1·36	·71	·80	·12	·135	7·3	8·0	·48	·61	·60	·75	2/6	3/6	—	—
June ,,	1·01	1·35	·56	·68	·09	·11	5·7	6·4	·38	·61	·58	·81	4/9	5/9	—	—
July ,,	1·52	1·67	·90	·97	·14	·16	8·3	8·8	·64	·72	1·13	1·40	7/7	6½/7	—	—
August ,,	·80	1·17	·70	·76	·11	·14	6·2	7·4	·33	·53	·57	·86	3/4	3/4	—	—
September ,,	·98	1·20	·49	·61	·11	·135	5·9	7·2	·41	·55	·60	·90	2/6	4/6	—	—
October ,,	·73	1·01	·33	·52	·08	·105	4·9	5·6	·29	·40	·32	·62	½/7	2½/7	—	—
November ,,	·82	·76	·23	·27	·07	·075	3·5	3·6	·29	·30	·30	·29	0/8	0/8	—	—
December ,,	·81	1·16	·38	·53	·095	·13	4·6	5·4	·32	·51	·34	·65	0/6	1/6	—	—
January 1927	·70	1·03	·28	·40	·075	·10	4·1	4·8	·24	·40	·27	·42	0/7	1½/7	—	—
February ,,	·78	1·09	·29	·46	·075	·11	4·4	5·2	·29	·46	·33	·59	0/7	2½/7	—	-
March ,,	·80	1·02	·24	·29	·06	·08	3·6	4·2	·31	·44	·34	·45	0/7	1/7	—	—
Average	·93	1·21	·48	·60	·095	·12	5·5	6·3	·37	·53	·50	·73	24/81	35½/81	35%	38%
Average for year ending:— March, 1926	1·03	1·25	·56	·67	·11	·125	5·8	6·5	·45	·57	·61	·83	32½/85	38/85	36%	46%
March, 1925	·93	1·12	·44	·53	·11	·12	4·7	5·4	·39	·51	·57	·68	38/95	40/95	46%	33%
,, 1924	1·03	1·17	·56	·66	·135	·145	5·3	6·5	·44	·53	·59	·66	22½/86	20/86	34%	25%
,, 1923	1·11	1·26	·58	·69	·145	·16	5·4	6·6	·50	·58	·59	·66	26½/83	25/83	18%	14%
,, 1922	1·09	1·33	·66	·82	·135	·16	5·6	6·8	·49	·61	·63	·80	32/81	41/81	29%	31%
,, 1921	1·01	1·19	·51	·66	·13	·15	5·4	6·3	·46	·56	·54	·64	21½/76	25/76	17%	14%
,, 1920	1·19	1·42	·60	·74	·125	·145	5·9	7·1	·54	·67	·77	·95	40/76	40/76	43%	42%
,, 1919	1·05	1·25	·45	·54	·095	·11	5·2	5·7	·48	·59	·52	·62	25/86	27/86	8%	5%

A=Sample taken above the outlet of effluent from the works. **B**=Sample taken below the outlet of effluent from the works.

DAVYHULME WORKS.

Table XIV.

TABLE XIV.—PARTICULARS *RE* COST FOR SEWAGE DISPOSAL OF THE CITY OF MANCHESTER AT THE DAVYHULME WORKS, 1896 to 1927.

Year ending		Maintenance charge		Capital charge		Total outlay on purification works to date	Total capital and maintenance charges		Per cent. purification of raw sewage		Average number of population connected to sewers
		Total per annum	Cost per head of population	Total per annum	Cost per head of population		Total per annum	Cost per head of population	As measured by the 4 hours oxygen absorption test	As measured by the albuminoid ammonia test	
		£	Pence	£	Pence	£	£	Pence	Per cent.	Per cent.	
December,	1896	15,780	10·4	8,129	5·4	162,572	23,909	15·8	......	......	363,040
,,	1897	19,089	9·9	9,797	5·1	195,942	28,886	15·0	......	......	462,020
,,	1898	20,000	9·3	10,517	4·9	210,334	30,517	14·2	......	......	515,120
March,	1900	18,728	8·1	10,634	4·6	212,672	29,362	12·7	......	......	553,910
,,	1901	21,439	9·2	10,793	4·6	215,866	32,232	13·8	39	38	558,812
,,	1902	19,212	8·2	12,395	5·3	247,893	31,607	13·5	40	40	564,200
,,	1903	15,512	6·6	17,473	7·4	349,457	32,985	14·0	38	41	567,570
,,	1904	14,684	6·1	21,316	8·7	426,323	36,000	15·0	45	52	574,130
,,	1905	14,273	6·0	23,506	9·8	470,121	37,779	15·8	68	71	575,270
,,	1906	18,648	7·8	24,069	10·0	481,374	42,717	17·8	70	74	575,900
,,	1907	21,795	9·1	24,029	10·0	480,566	45,824	19·1	64	69	576,620
,,	1908	27,147	11·3	24,730	10·3	494,614	51,877	21·6	61	68	577,230
,,	1909	30,457	12·4	25,982	10·6	519,643	56,439	23·0	64	70	588,600
,,	1910	27,674	11·0	27,239	10·8	544,785	54,913	21·8	67	72	603,910
,,	1911	22,660	8·9	28,444	11·2	568,884	51,104	20·1	69	70	611,100
,,	1912	24,530	9·8	29,569	11·8	591,376	54,099	21·6	74	76	602,000*
,,	1913	28,730	11·4	29,928	11·9	598,567	58,658	23·3	74	76	605,000
,,	1914	31,634	12·3	30,540	11·9	610,794	62,174	24·2	77	78	616,000
,,	1915 (53 weeks)	32,347	11·4	30,832	10·8	616,637	63,179	22·2	71	71	682,000
,,	1916	30,871	9·8	30,857	9·8	617,149	61,728	19·6	71	72	755,000
,,	1917	26,818	8·5	31,121	9·9	622,425	57,939	18·4	68	71	755,000
,,	1918	30,798	9·6	31,121	9·7	622,425	61,919	19·3	62	63	768,000
,,	1919	34,954	11·0	31,121	9·8	622,425	66,075	20·8	58	61	764,000
,,	1920 (53 weeks)	61,805	19·4	31,683	9·9	633,676	93,488	29·3	54	60	765,000
,,	1921	92,595	28·8	31,840	9·9	636,805	124,435	38·7	51	55	770,500
,,	1922	97,298	31·5	32,088	10·3	641,764	129,386	41·9	54	59	741,600*
,,	1923	73,759	23·7	32,278	10·4	645,568	106,037	34·1	62	63	747,100
,,	1924	68,382	21·9	32,278	10 4	645,568	100,660	32·3	63	65	748,300
,,	1925	52,771	16·9	32,278	10·3	645,568	85,049	27·2	53	57	750,500
,,	1926 (53 weeks)	57,269	18·2	32,278	10·3	645,568	89,547	28·5	54	56	754,000
,,	1927	57,442	18·2	33,322	10·6	666,443	90,764	28 8	49	51	757,000

NOTE.—The capital charges given above include the cost of all land purchases at Davyhulme and Flixton.

The annual charges have been computed by taking 5 per cent. of the total outlay to date.

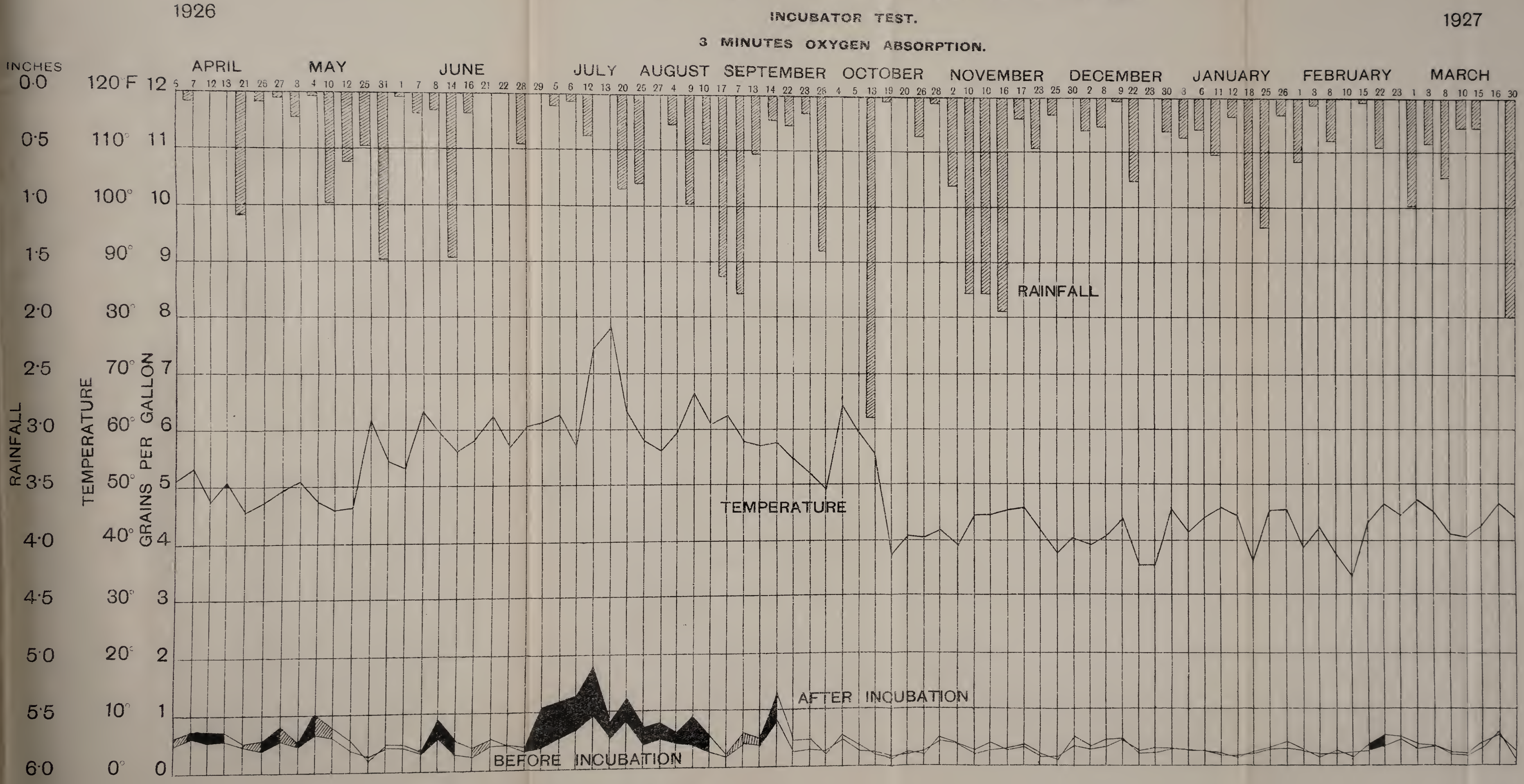
* The estimation of the population connected to the sewers was revised in the light of the latest census returns.

DIAGRAM 1

SHIP CANAL WATER ABOVE WORKS OUTFALL.

INCUBATOR TEST.

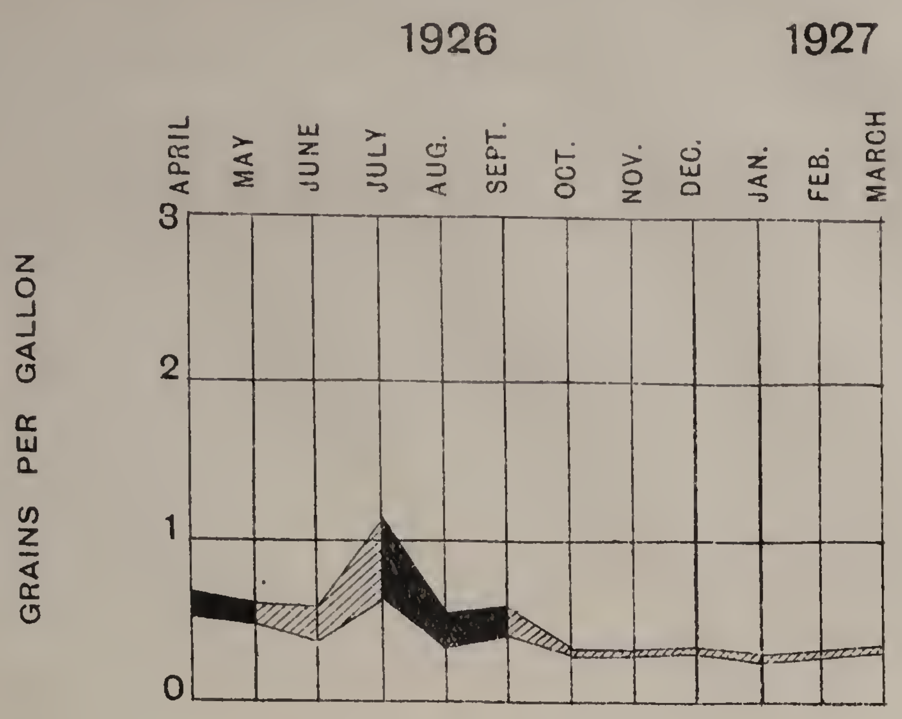
3 MINUTES OXYGEN ABSORPTION.



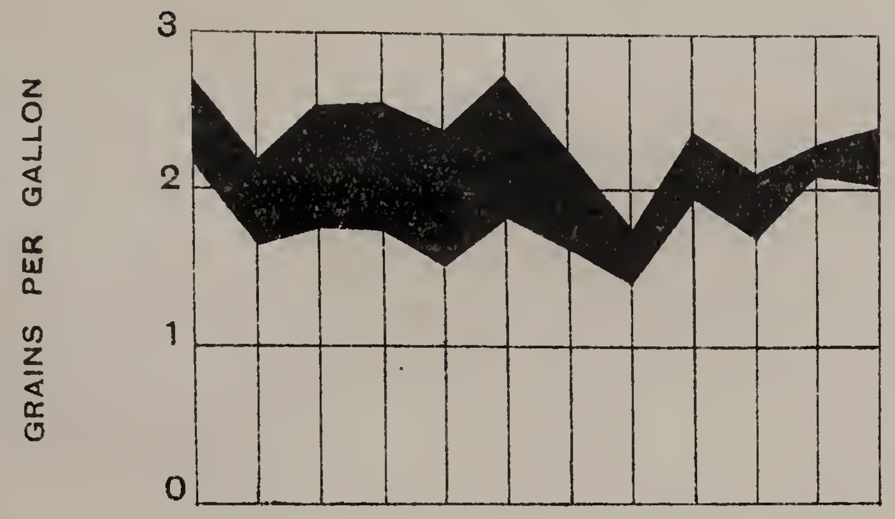
MONTHLY AVERAGES OF ANALYSES OF SHIP CANAL WATER TAKEN ABOVE AND BELOW WORKS OUTFALL, AND AVERAGE EFFLUENT FROM WORKS.

DIAGRAM 2.

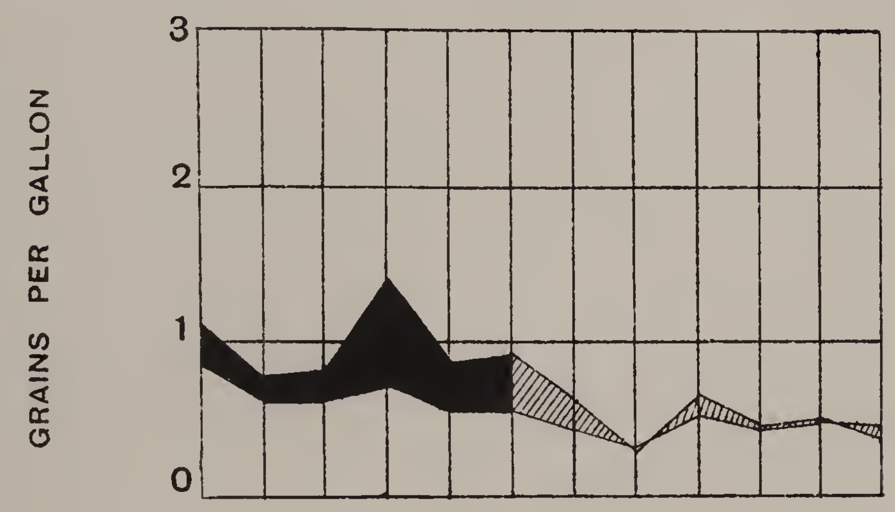
INCUBATOR TEST. **3 MINUTES OXYGEN ABSORPTION.**



ABOVE WORKS OUTFALL



AVERAGE EFFLUENT



BELOW WORKS OUTFALL

AVERAGE PER CENT. INCREASE AFTER INCUBATION